Public Roads

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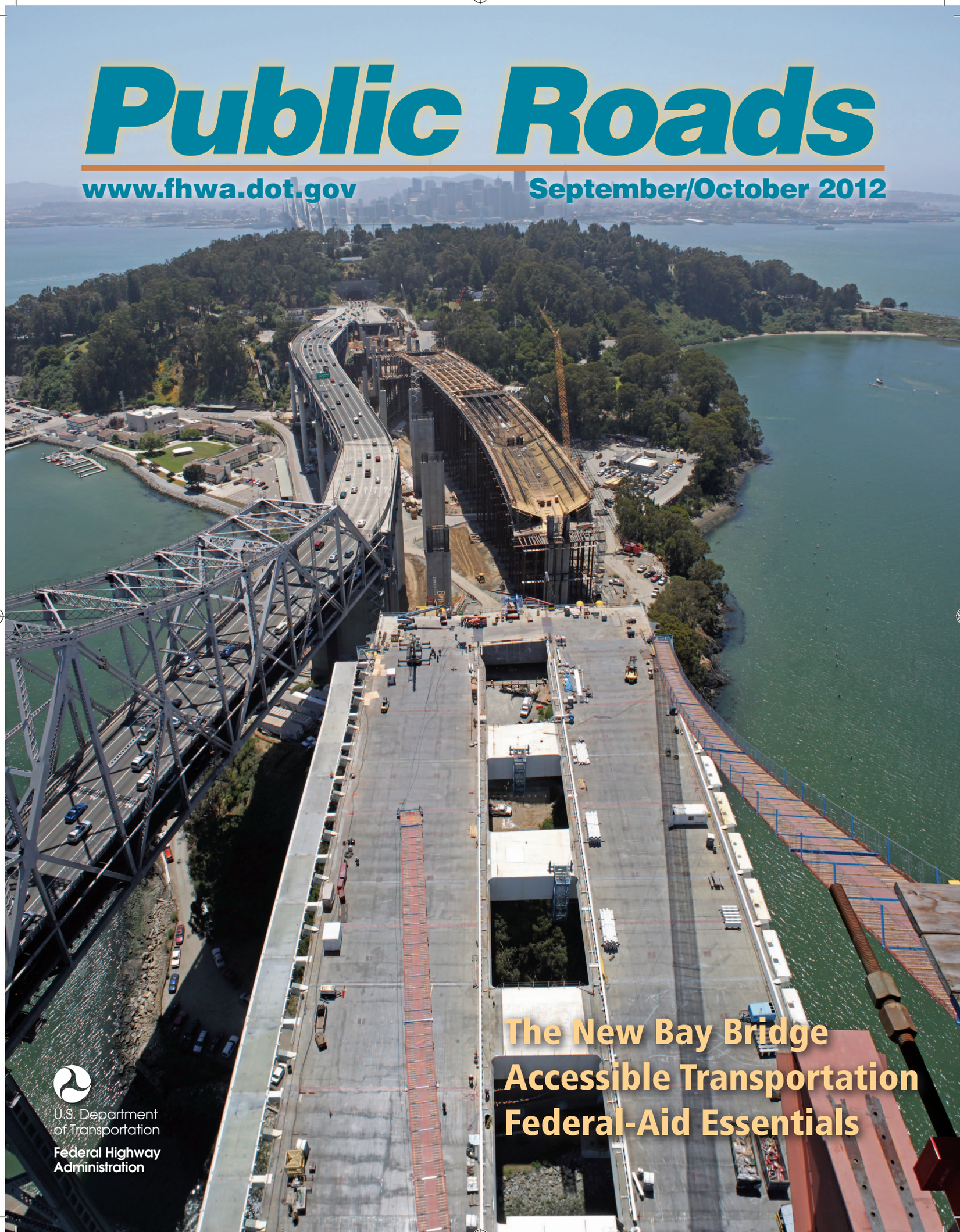
September/October 2012



The New Bay Bridge
Accessible Transportation
Federal-Aid Essentials

U.S. Department of Transportation
Federal Highway Administration

Public Roads

—featuring developments in Federal highway policies, programs, and research and technology—

September/October 2012 www.fhwa.dot.gov Vol. 76, No. 2

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Front cover—Shot from the highest point of the San Francisco-Oakland Bay Bridge's new east span, this photo shows ongoing construction between Oakland, CA, and Yerba Buena Island in June 2011. After parts of the bridge were severely damaged during the Loma Prieta earthquake in 1989, the California Department of Transportation decided to replace the east span to ensure continued safe operation. For more information, see "Bridging the Bay" on page 2 in this issue of PUBLIC ROADS. *Photo by Greg Kolle, FHWA California Division.*

Back cover—Locally administered projects, such as the David Kreitzer Lake Hodges Bicycle/Pedestrian Bridge in San Diego County, CA (shown here), make up about 15 percent of all Federal-aid projects nationwide. A Federal Highway Administration initiative called Federal-aid Essentials for Local Public Agencies provides short videos and other resources designed to help local public agencies manage their projects successfully. For more information, see "Federal-Aid Essentials" on page 16 in this issue of PUBLIC ROADS. *Photo by Vito Palmisano, Palmisano Photo Ltd.*

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Public Roads (ISSN 0033-3735; USPS 516-690) is published bimonthly by the Office of Research, Development, and Technology, Federal Highway Administration (FHWA), 1200 New Jersey Avenue, SE, Washington, DC 20590. Periodicals postage paid at Washington, DC, and additional mailing offices.

POSTMASTER: Send address changes to *Public Roads,* HRTM, FHWA, 6300 Georgetown Pike, McLean, VA 22101-2296.
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Public Roads is sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Requests for subscriptions should be sent directly to New Orders, Superintendent of Documents, P.O. Box 979050, St. Louis, MO 63197-9000. Subscriptions are available for 1-year periods. Paid subscribers should send change of address notices to the U.S. Government Printing Office, Claims Office, Washington, DC 20402.

The electronic version of *Public Roads* can be accessed through the Turner-Fairbank Highway Research Center home page (www.fhwa.dot.gov).

Guest Editorial

Helping Local Public Agencies Deliver Federal-Aid Projects

The job of building, maintaining, and operating the national highway system entails a number of inherent challenges, not the least of which is the fact that most of the nearly 4 million-mile (6.4 million-kilometer) system is owned and operated at the local level. About three-quarters of the entire system, some 2.9 million miles (4.7 million kilometers), is managed by nearly 28,000 local public agencies, mostly counties, cities, and towns.

These agencies receive about $7 billion annually in Federal-aid funding, or roughly 15 percent of the entire budget for the Federal-Aid Highway Program. Along with administering the allocation of funding, local public agencies assume responsibility for adhering to all Federal laws and regulations governing the program. The Federal Highway Administration (FHWA) and State departments of transportation (DOTs), in turn, are charged with supporting local public agencies in the delivery of transportation improvements, while ensuring appropriate use of public funds.

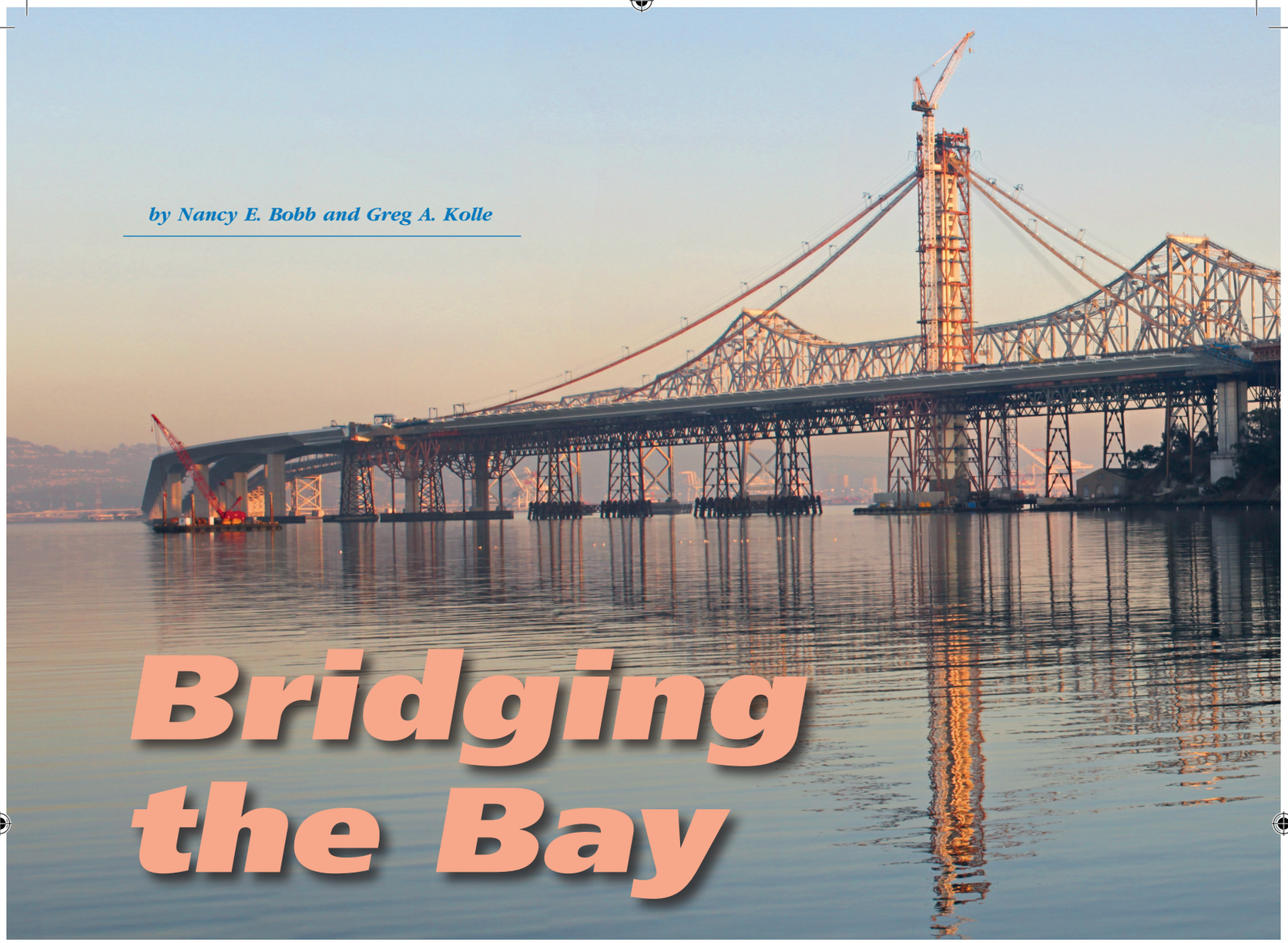
Assisting local public agencies requires FHWA and State DOTs to oversee and share information about a huge geographic distribution of local projects. Although some of the larger local public agencies are frequent recipients of Federal-aid highway funds and understand what is required of them, many smaller ones have less experience with the program. In the past, accurate information about Federal-aid requirements pertaining to local roads was scattered across various Web sites or buried deep within thick manuals. But not anymore.

FHWA, working closely with its State and local partners, recently launched an initiative called Federal-aid Essentials for Local Public Agencies. The initiative puts key information about Federal-aid requirements on a single public Web site at www.fhwa.dot.gov/federal-aidessentials. Local public agency staffers now have at their fingertips a centralized hub for guidance, policies, procedures, and best practices for administering Federal-aid projects.

The Web site's main feature is a resource library of some 80 videos covering most aspects of the process of project development and delivery. Available from any computer or mobile device with Internet access, the videos are short, concise, illustrated with graphics, and narrated in plain language. Each addresses a single topic within a critical focus area, such as finance, civil rights, environment, right-of-way, project development, and project construction and contract administration. Companion materials, such as links to relevant manuals and forms, accompany each video, along with references to the appropriate sections in the Code of Federal Regulations. For more information on this initiative, see "Federal-Aid Essentials" on page 16 in this issue of PUBLIC ROADS.

The goal is to provide the right information at the right time for partners at the local level. By centralizing these types of information, Federal-Aid Essentials for Local Public Agencies is providing transportation professionals with a convenient and inexpensive way to obtain vital information on administering federally funded projects. Ultimately, this information will be of value to a wide range of Federal, State, and local professionals who are working to deliver needed transportation improvements to the traveling public.

Jeffrey F. Paniati, P.E.
Executive Director
Federal Highway Administration



by Nancy E. Bobb and Greg A. Kolle

Bridging the Bay

The San Francisco-Oakland east span, a 1930s landmark, is being replaced by a seismically advanced structure designed to last for 150 years.

For more than three-quarters of a century, the San Francisco-Oakland Bay Bridge has facilitated the movement of people and goods throughout the bay area of northern California. Known locally as the Bay Bridge, the double-decked east span structure carries Interstate 80 and more than 280,000 vehicles per day between Oakland and the Yerba Buena Island tunnel.

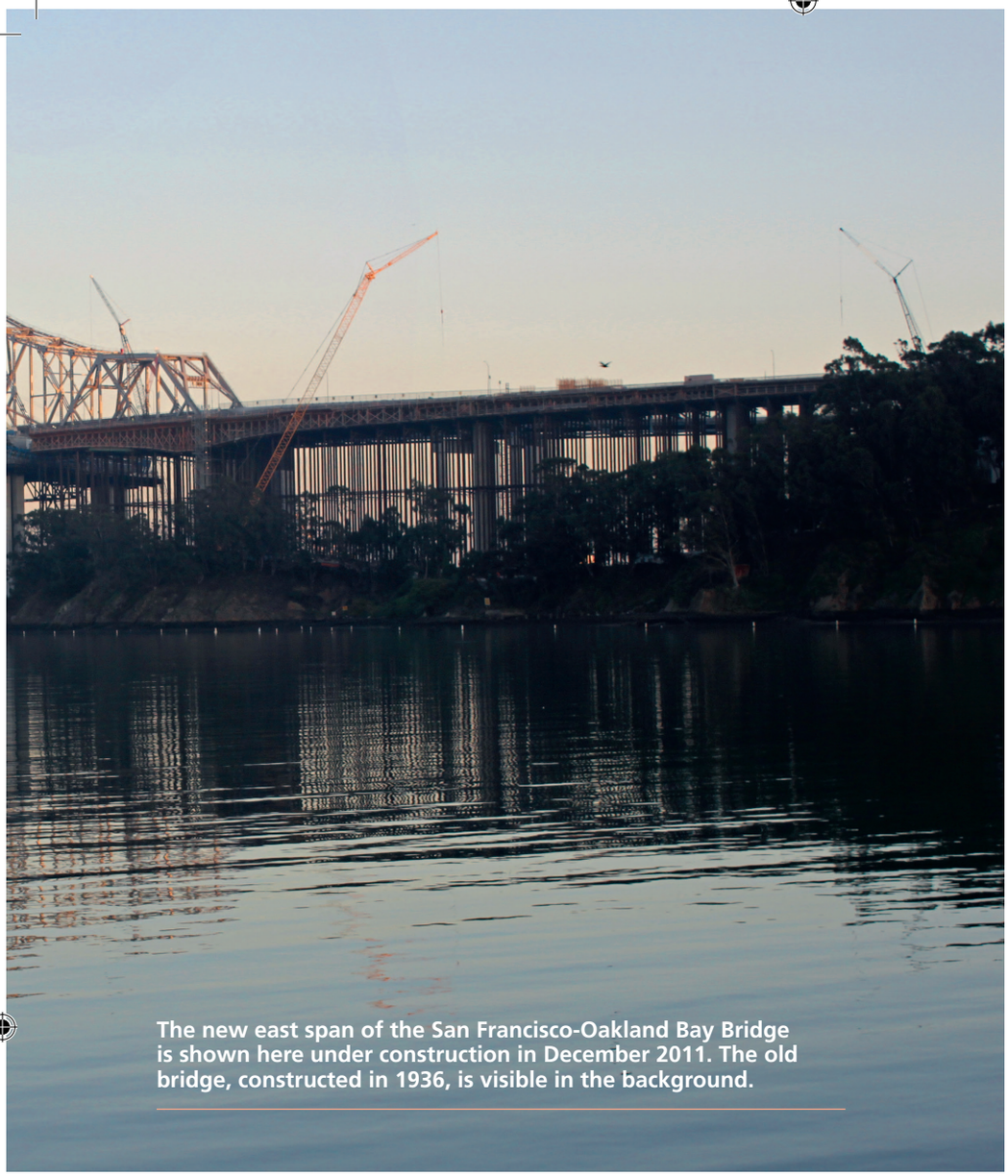
For years, officials with the California Department of Transportation (Caltrans) had been concerned about the aging bridge and its crack-susceptible eyebar design. Then, after the Loma Prieta earthquake in 1989 severely damaged the bridge's east span, Caltrans officials decided the time had come to replace that span with a new bridge that meets modern seismic and safety standards. The preliminary work started shortly after the Loma Prieta earthquake, and construction continues today as the new structure nears completion.

"For 75 years, the Bay Bridge has been the workhorse of the bay area transportation network," says Andrew B. Fremier, deputy executive director of operations with the Metropolitan Transportation Commission for the San Francisco Bay area. "When the spectacular new east span of the bridge opens next year, the Bay Bridge will be recognized around the world as both a workhorse and a show horse."

Here's a look at the past, present, and future of the Bay Bridge and its newest span, which is designed to withstand the shaking associated with an earthquake seismologists expect to occur only once every 1,500 years.

A History of Growth

In 1769, Spanish explorers discovered the entrance to the San Francisco Bay and its surrounding lands, which eventually would house the populous modern-day cities of Oakland, San Francisco, and



The new east span of the San Francisco-Oakland Bay Bridge is shown here under construction in December 2011. The old bridge, constructed in 1936, is visible in the background.

Governor C. C. Young formed the Hoover-Young San Francisco Bay Bridge Commission, bringing together stakeholders to find a solution. The solution was a bridge.

The Original Bay Bridge

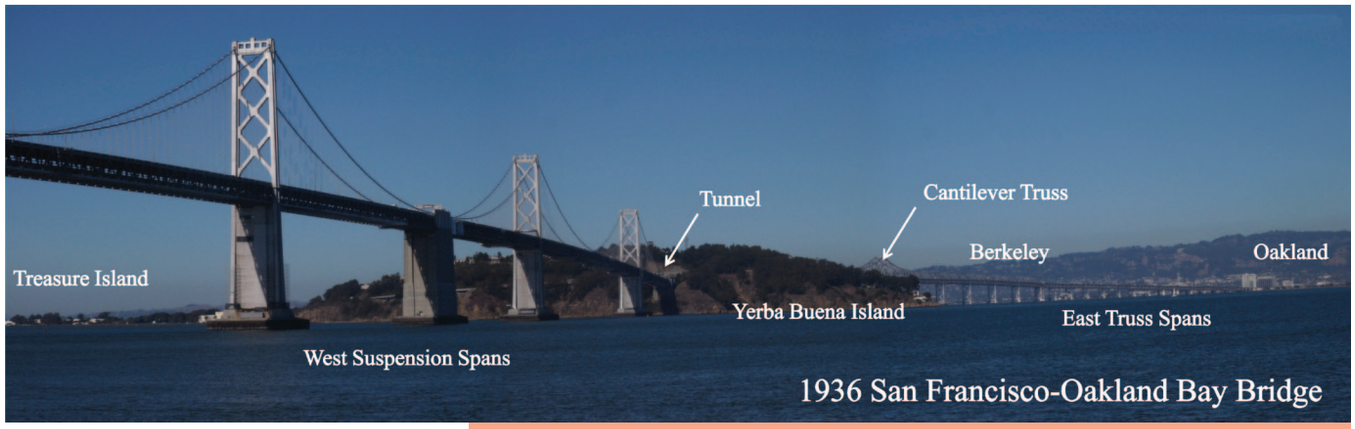
The first bridge crossing the bay between San Francisco and Oakland opened to traffic on November 12, 1936. The structure consisted of two back-to-back suspension spans, a tunnel on Yerba Buena Island, a cantilevered truss span, and several through and deck truss spans. Construction of the bridge, the longest in the world at the time, began in 1933 at a cost of $77 million, funded through the Reconstruction Finance Corporation, a former U.S. Government agency that lent money to facilitate economic development in the 1930s. At about the same time, the Golden Gate Bridge also was constructed.

The construction project employed more than 8,300 workers and took more than 3 years. The original configuration featured a double-decked design, which carried electric trains and trucks on the bottom level and passenger vehicles on the top level. Each level was bidirectional. In 1958 the electric trains ran for the last time, and, by 1963, the bridge was reconfigured to five westbound lanes on the upper deck and five eastbound lanes

San José. From the establishment of the 21 Franciscan missions along the coast between 1769 and 1823 to the discovery of gold in California in 1848, San Francisco's population boomed, increasing from 1,000 to 20,000 residents by 1850. The bay area's population was swelling on the eastern shores at Oakland as well. During that time, ferry service was the only mode of transport across the bay to San Francisco. By 1856, talks of building a bridge to connect the two cities had begun. However, technology to construct a bridge of such magnitude would not catch up for another 80 years.

Growth in the bay area continued to climb, with San Francisco's population soaring to more than 500,000 in 1920, overtaxing the capacity of the railroads and ferries in the region. When Herbert Hoover, a graduate of nearby Stanford University, was elected President in 1928, he was well aware of the need for a bay crossing. Soon after he took office, President Hoover and California's then

Misión San Francisco de Asis, commonly known as Mission Dolores, was established on June 29, 1776, and is the oldest building in San Francisco. Establishment of the Franciscan missions is responsible, in part, for San Francisco's early population growth and the need for a bay crossing.



The existing San Francisco-Oakland Bay Bridge, shown here looking east from San Francisco, includes east and west spans that are connected by a tunnel through Yerba Buena Island.

on the lower deck. The first year of service after the reconfiguration saw 9 million vehicles cross the bridge. Today, the Bay Bridge carries more than 102 million vehicles annually.

Earthquakes: A Force To Reckon With

Much of the bay area's written history is marred by earthquakes. Of the many recorded quakes, significant damage occurred during those in 1812, 1856, 1865, 1868, 1897, 1898, 1906, 1957, and 1989.

Injuries occurred in many of the seismic events, as well as fatalities in the 1868, 1906, and 1989 quakes. Notably, the 1906 earthquake was the most devastating, causing more than 3,000 fatalities.

The extent and type of physical damage have varied for each earthquake. Most of the destruction affected brick structures such as walls and chimneys, buildings and structures constructed along the bay on manmade ground (usually infilled soils excavated from the bay), and gas and water pipelines embedded in the ground. Fissures, some with water spewing from them, were noted in some areas, with gaps ranging from 1 to 6 inches (2.5 to 15.2 centimeters). Water levels

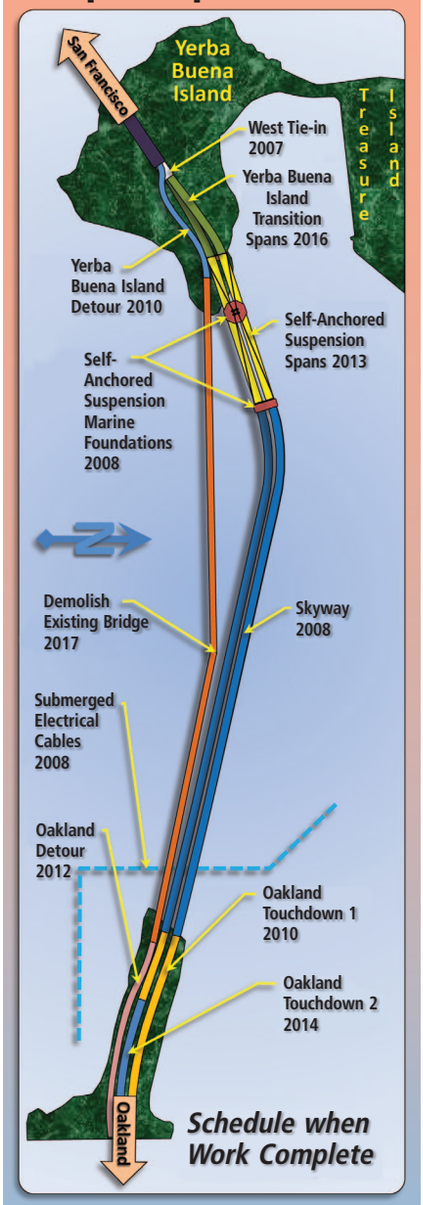
H.G. Wilshire, U.S. Geological Survey

C.E. Meyer, U.S. Geological Survey

(Above) During the Loma Prieta earthquake, the Bay Bridge suffered failures in the deck span, visible here near the interface of the cantilever and truss sections.

(Left) These sections of the Cypress Street Viaduct in Oakland, CA, collapsed during the 1989 Loma Prieta earthquake.

Schedule of the East Span Replacement



Source: Caltrans, San Francisco Bay Area Toll Bridge Seismic Retrofit and Regional Measure 1 Programs 2011 Fourth Quarter Report, *February 2012.*

in the bay also were affected during and after some of the events.

Without question, the Loma Prieta earthquake in 1989 had the most impact on the bay area's transportation structures. The quake damaged more than 80 bridges, with 10 needing temporary shoring and another 10 closed due to severe damage. On three bridges, one or more spans collapsed. The most severe damage occurred to older structures on less stable ground, such as the Cypress Street Viaduct, the collapse of which resulted in 42 fatalities. One death also occurred when 50-foot (15-meter) spans failed on the Bay Bridge.

The 1989 quake revealed how critical the bridges crossing the bay area had become in keeping the region functioning. It underscored the need for bay area bridges to be able to withstand strong earthquakes. Given the frequency and severity of such events in the region, today's bridge standards require every structure of significance to be constructed to withstand considerable seismic accelerations. To meet this need, Caltrans was required to perform seismic retrofits to bring the bay area toll bridges up to current standards. The task quickly became a high priority in the bay area and throughout California.

Retrofitting the Inventory

Today, Caltrans owns and operates 7 bay area crossings, which include 10 bridges at Antioch, Benicia-Martinez (2 bridges), Carquinez (2 bridges), Dumbarton, Richmond-San Rafael, San Francisco-Oakland Bay Bridge (2 bridges), and San Mateo-Hayward. Necessary seismic retrofits of these bridges have been completed or are currently under construction through the State's Toll Bridge Seismic Retrofit Program.

In the aftermath of the Loma Prieta quake, Caltrans' engineering staff examined each bridge to determine what retrofit work needed to be done based on traffic loads, expected remaining life, cost of higher post-earthquake performance levels, and other considerations. Each retrofit was designed to a level that, at a minimum, ensures that the bridge, although possibly damaged, will remain standing during an earthquake. For example, the Bay Bridge is located between and within approximately 10 miles of two fault lines, the Hayward Fault that lies to the east and the San Andreas Fault that lies to the west. These faults are capable of producing 7.5 and 8.0 magnitude earthquakes, respectively. Caltrans designed the new bridge to be in service within 24 hours of an earthquake generating motions that are expected to occur once every 1,500 years.

Caltrans gave special consideration to the Bay Bridge and the Benicia-Martinez Bridge, which the California State Legislature designated as "lifeline structures" because of their locations along transportation corridors crucial for emergency relief and economic revitalization following a major earthquake. Based on this distinction, the retrofit strategies for these two bridges incorporated some design elements that exceed the requirements of standard seismic bridge design.

Specifically, Caltrans determined that a seismic retrofit of the Bay Bridge's east truss span would not be cost effective, and after much deliberation of engineering analysis and costs, and public involvement, the agency decided replacement was the best option.

The total current estimated cost for the scheduled seismic retrofit projects is $9.1 billion, which includes the Bay Bridge's

This view looking west from the top of the cantilever truss on the existing bridge shows the steady progress on the new span (right) as of January 2010. To the far right is the shear-leg barge crane built specifically for this project.

These crew members are on Yerba Buena Island inspecting the tower "tipping" cable anchors, which tip the tower slightly to the west until the suspension cable can carry the weight of the deck. The forest of falsework in the background supports the cast-in-place concrete westbound transition spans.

east span replacement at approximately $6.3 billion. Toll revenues paid for most of the seismic retrofit work, which was performed through several contracts.

East Span Replacement Project

Replacing the Bay Bridge's east side span has occurred in several phases. In 1998, Caltrans selected a single-tower self-anchored suspension (SAS) design as the signature span for the bridge. The SAS span, a design preferred by stakeholders and the public because of its appearance, has one continuous suspension cable and two anchorage points built into the superstructure. Comparatively, a typical suspension bridge has two suspension cables, each with two anchorages into the ground.

Because the new bridge connects to an existing tunnel and the west side's suspension bridge, both of which are limited to five lanes in each direction, Caltrans did not increase the capacity for the new span. However, the design included a pedestrian/bike path mounted on the south side of the bridge, with access to Yerba Buena Island from Oakland.

After an extensive environmental review process, construction began in 2002 on the segmental concrete box viaduct, or Skyway section of the bridge. The Skyway is the easternmost section and stretches 1.2 miles (1.9 kilometers) from the Oakland touchdown structures to the SAS span. The design is two parallel precast concrete segmental box structures made of 452 segments on 28 pier columns. Caltrans completed the Skyway section in 2008.

In 2010, the agency completed construction of the foundations and spans for the Yerba Buena Island detour, which carries traffic over the east side of the island during construction of the transition spans. The SAS span tower foundation and east pier were completed in 2008. The Oakland touchdown detour, completed in 2012, carries traffic

The formwork for the westbound transition superstructure is shown here, from the top of the new tower, nearly completed in late June 2011.

just south of the construction area so the touchdown can be completed concurrently with the SAS and the Yerba Buena Island transition spans.

Innovative Scheduling Solutions

As the largest bridge project in California's history, the Bay Bridge's east span replacement required the monumental task of monitoring the progress of 21 contracts. Caltrans had to keep track of each contract to prevent costly delays and to analyze the potential risks. Should one contract be accelerated or should another be delayed? What are the costs, the effects on schedules, and impacts on the other project contracts? To address these questions and assist management with decisionmaking, Caltrans developed a Corridor Schedule Team.

The Corridor Schedule Team made a number of recommendations along the way to mitigate potential risks to the construction schedule. In particular, two suggested measures significantly improved the project schedule: the Yerba Buena Island detour and the Oakland touchdown detour.

Construction of the Yerba Buena Island detour structure limited disruption by shifting traffic off the original roadway over Yerba Buena Island and onto a temporary detour. Crews then could demolish the existing spans west of the cantilever truss and construct the transition structures on Yerba Buena Island concurrent with the construction of the SAS spans.

In the first of two phases, the single-level west tie-in structure was precast and rolled into place during a weekend bridge closure over Labor Day in 2007. Caltrans then constructed the remaining portion of the detour structure and prepared the existing structure for removal. Two years later, during another Labor Day weekend closure, Caltrans removed the existing double-decked truss span and slid the east end of the detour into place, completing the detour. These measures helped to keep traffic disruptions between San Francisco and Oakland to a minimum.

The second strategy involved redesigning and advancing the construction of the Oakland touchdown by building a shoofly detour (a short, temporary bypass) to divert traffic just south of the existing roadway. Caltrans completed most of the work prior to the 2012 Presidents Day weekend closure. Before the detour went into effect, construction of the new eastbound lanes was blocked by the original bridge's westbound lanes. This detour has enabled Caltrans to build the permanent eastbound touchdown at the same time as the SAS spans and the transition structure, shortening the total project timeline by an estimated 4–6 months. The detour also means Caltrans can switch both directions of traffic simultaneously when the new bridge is complete.

"Using an innovative risk management program has enabled us to analyze risks to multiple contracts and make modifications that minimize impacts to budget and schedule," says Tony Anziano, toll bridge program manager with Caltrans. "The work performed on Yerba Buena Island and on our Oakland touchdown will give us the ability to open the entire bridge at once ahead of our previous schedule."

Facts and Figures for the East Span Replacement Project

- The original east span of the Bay Bridge suffered damage in the Loma Prieta earthquake in 1989 when 50-foot (15-meter) spans failed.
- Estimated at $6.3 billion, the east span replacement is one of the largest bridge construction projects in the United States.
- The east span replacement is designed to withstand the shaking associated with an earthquake seismologists expect to occur only once every 1,500 years.
- The Skyway is the longest section of the new east span at 1.2 miles (1.9 kilometers).
- The Skyway design is two parallel precast concrete segmental box structures made of 452 segments on 28 pier columns.
- The SAS suspension cable has 137 strands, each with 127 wires, for a total of 17,399 wires.
- The SAS span is the largest of its kind in the world and has only one tower and one main cable.
- The opening day for traffic on the new bridge is planned for Labor Day 2013.

Status of SAS and Transition Spans

Construction on the signature section of the bridge, the SAS span, began after completion of the tower foundation and the east pier in 2008. Caltrans started the SAS span by constructing a complex structure of steel truss falsework to support the deck sections.

In January 2010, a shear-leg barge crane built specifically for this project began placing SAS deck sections at the west end of the previously installed steel truss falsework. The deck sections were supported by the falsework until the suspenders

The shear-leg barge crane places the last piece of the SAS deck section, which houses an anchorage area for the suspension cable strands.

Here, a Caltrans inspector ensures the wires of the suspension cable strands are facing the proper direction. The visible wooden wedges are used to install the strands.

could transfer the deck load to the suspension cable. However, before the transfer, the workers had to construct many additional bridge elements. For example, the tower foundation awaited tower legs, several deck sections needed to be installed and welded together, the suspension cable needed to be strung, and suspender clamps and cables needed to connect the deck sections to the suspension cable.

The westbound transition superstructure, which connects the SAS section to Yerba Buena Island, consists of cast-in-place, post-tensioned concrete box girder spans. By June 2011, Caltrans had nearly completed formwork for the westbound transition structure and, by August, much of the westbound transition span was cast.

"Construction progress has been great for both the SAS and the transition structures," says FHWA California Division Administrator Vincent Mammano. "When the tower went up and the four suspension cable catwalks were draped from the tower to the deck in June 2011, it was like the raising of a flag. The bridge became visible to the bay area."

On October 28, 2011, Caltrans reached a major milestone when it placed the last deck section at the northeast corner of the SAS span. This section houses one of the anchorages for the suspension cable strands and signaled the start of placing the suspension cable. Caltrans' next step was to install the cable haul assemblies needed to carry each of the 137 suspension cable strands from spools up to the tower, down and around the three saddle plates of the west end, back up over the tower, and finally to the southeast anchorage.

The suspension cables of typical suspension bridges are built by stringing a single wire back and forth between anchorages until the required number of wires is met. When a spool runs out of wire, the wire of the next spool is connected by a splice. The SAS suspension cable strands have no splice locations because they are constructed with continuous 1-mile (1.6-kilometer)-long wires that run from anchorage to anchorage. Strand installation is much faster than single wire installation. The SAS suspension cable has 137 strands, each with 127 wires, for a total of 17,399 wires.

When installing the cables, the workers have to push each strand between saddle plates at the seven saddle locations along the SAS span. To ensure that there are no twists in the strands, two wires are colored in each strand, one blue and one red, which are inspected at each saddle. Each wire is galvanized and has an application of grease to help prevent corrosion. When all the strands are in place, the workers then compress

The two grooves in the tower saddle will hold the suspension cables. Phillip Ditzler, former acting division administrator of the FHWA California Division and current division administrator of the FHWA Oregon Division, shows the scale of the saddle.

This view of the southeast anchorage shows 26 strands that have been tensioned and 2 strands awaiting tensioning, with several others yet to be installed.

them into a round shape. After being shaped, the cables receive an application of a zinc-rich paste to prevent corrosion, are wrapped with S-wires (an interlocking flat wire with an "S" cross-section), and are coated with an elastic primer and paint.

The Caltrans construction crew installed the first strand in December 2011. By June 2012, Caltrans had installed all of the 137 strands. The workers used timber blocks to wedge the plates and to press the strands deep into the saddles. Each strand was numbered and had a designated location at each saddle and at the anchorages.

In February 2012, Caltrans completed the Yerba Buena Island westbound transition spans including post-tensioning, and progressed with removal of the falsework. Simultaneously, crews were installing falsework and forms in preparation for casting the eastbound transition spans. The transition spans are scheduled to be ready for the estimated 2013 bridge opening.

"When this project opens to the public, they will be awed by what they behold," says Kenneth Terpstra, Caltrans' project manager for the east span replacement. "Personally, I'm struck by the passion of the myriad of disciplines involved: engineers, seismologists, architects, contractors, environmentalists, and administrators. These professionals are producing a project that solves the most difficult engineering, seismic, and architectural challenges."

Remaining Steps To Completion

With the installation of the suspension cable complete, the construction crews are clamping suspender cable hardware onto the cable at strategic locations in preparation for transferring the weight of the deck to the suspension cable. After the deck weight is transferred to the suspension cable, Caltrans will remove the falsework trusses. At the same time the SAS falsework is being removed, the eastbound transition spans are schedule to be completed.

The opening day for traffic on the new bridge is planned for Labor Day of 2013, with demolition of the old bridge beginning soon after.

"The replacement of the east span of the San Francisco-Oakland Bay Bridge is a historic project," says San Francisco Mayor Edwin Lee. "Not only does it ensure the safety of the hundreds of thousands of commuters, residents, and visitors who cross the bridge every day, but it is also an example of innovation, architecture, and engineering that the San Francisco Bay area is known for throughout the world. This replacement represents an investment in our critical infrastructure and creating jobs, and I am looking forward to the opening of the new east span next year."

Nancy E. Bobb was the major project oversight manager and director of State programs with the FHWA California Division Office before retiring in 2008. For 6 years, she served as the major project oversight manager of the project to replace the east span of the Bay Bridge. She holds a B.S. in civil engineering from the University of Nevada, Reno, and an M.S. in civil engineering from the University of California, Davis.

The SAS tower stands tall over Yerba Buena Island during construction in February 2012.

Greg A. Kolle is a bridge engineer with the FHWA California Division Office. Since 2008, he has served as the major project oversight manager for the project to replace the east span of the Bay Bridge. After serving in the U.S. Air Force from 1972–1976, Kolle received his B.S. in civil engineering from North Dakota State University at Fargo.

For more information, visit baybridgeinfo.org or contact Greg Kolle at 916-498-5852 or greg.kolle@dot.gov. *The authors would like to thank the Caltrans District 4 project staff, their consultant designers, the Bay Area Toll Authority, the Toll Bridge Program Oversight Committee, the city of San Francisco, and the contractors' staff for taking the time to accommodate site visits for this article.*

The New Frontier in Accessible Transportation

by Mohammed Yousuf and Mark Fitzgerald

From DSRC to robotics, innovations that help travelers with disabilities also can enhance the road experience for seniors, bicyclists, delivery workers, and moms and dads.

Last year Mark Riccobono made history at the Daytona International Speedway, driving a sport utility vehicle—without the use of his eyes. Riccobono, executive director of the Jernigan Institute of the National Federation of the Blind, is legally blind. But watching him drive solo around the track—as he did in front of thousands of people on January 29, 2011—spectators might never have guessed had it not been announced over the loudspeaker.

(Above) After this blind pedestrian's request to cross the street is communicated to the traffic controller using dedicated short-range communications, information about the pedestrian's location can be broadcast to all the other travelers on the network, including approaching vehicles.

The demonstration, one of the activities before the scheduled race, marked the first time a blind person drove a street vehicle in public without the assistance of a sighted person. With the help of nonvisual technology, Riccobono successfully navigated the 1.5 miles (2.4 kilometers) of the road course that branches off the multilane, oval racetrack. The road course veers off into the center of the oval and winds around as a curvy two-lane road before rejoining the main track. Riccobono managed the turns, avoided moving and stationary obstacles, and passed a van without collision.

Range-finding laser censors affixed to the vehicle sent information to an onboard computer that created

and updated a three-dimensional map of the road environment. Cued by electronic signals triggered by the computer, vibrating gloves and a vibrating strip on the car seat sent directional signals to Riccobono. The signals informed him which way to steer and when to speed up or slow down and brake.

"It was thrilling for me to be behind the wheel, but even more thrilling to hear the cheers from my blind brothers and sisters in the grandstands," Riccobono said in a news announcement released by the National Federation of the Blind shortly after the event. "It … [shows] that blind people can do anything that our sighted friends and colleagues can do as long as we have access to information through nonvisual means."

Riccobono's accomplishment is just one example of how technological innovation can benefit people with disabilities. At the Federal Highway Administration's (FHWA) Turner-Fairbank Highway Research Center (TFHRC), researchers are working on a suite of new technologies that have the potential to improve the lives of people with disabilities, senior citizens, and other members of the traveling public.

For example, intelligent transportation systems (ITS), accessible data, wireless communications, mobile computing, robotics, artificial intelligence, and object detection navigation offer many possibilities for increasing mobility and independence. Designing wayfinding, orientation, and guidance technologies into personal vehicles, public transport systems, ticketing and travel information mechanisms, terminals, intersections, and pedestrian infrastructure can enhance the experience of traveling for everyone—including those with special needs.

New Momentum

Research in accessible transportation has gained momentum in recent years as result of Federal initiatives. In July 2010, in commemoration of the 20th anniversary of the Americans with Disabilities Act, the White House partnered with the Federal Communications Commission and the U.S. Department of Commerce to facilitate a discussion among technologists and disability advocates about innovative uses of the Internet to improve accessibility. The discussion led to the following challenge: How can transportation data and other geodata be used to increase accessible travel for people with disabilities?

Over the next 3 months, participants collaborated via conference calls, email, and Web sites and produced a comprehensive report, *Data-Enabled Travel: How Geo-Data Can Support Inclusive Transportation, Tourism, and Navigation through Communities.* The report calls for a number of policy and research interventions and highlights transportation needs of deaf people and those with developmental disabilities, mass transit needs for the nondriving disabled, and prejourney travel information requirements for the elderly and disabled. The report also offers information about universal design (solutions that are effective for everyone, not just people with disabilities) and expanding transit systems, as well as emerging technologies that could pose barriers to people with disabilities if not accessible to them.

On February 23, 2011, FHWA conducted a workshop to examine technological innovations in accessible transportation and better understand the requirements of pedestrians and travelers with visual impairment or other disabilities. The workshop identified several areas of focus—including ITS, wireless communications, and robotics—where research could lead to new approaches in personal mobility and assess technological viability and capabilities. (For *Technological Innovations in Transportation for People With Disabilities Workshop Summary Report*, see www.fhwa.dot.gov/advancedresearch/pubs/11041/index.cfm.)

Costs and Benefits

More than one billion people worldwide live with a disability, according to the *World Report on Disability*, published in 2011 by the World Health Organization and World Bank. A study conducted by Cornell University and a subsequent report, *2009 Disability Status Report United States*, found that only 36 percent of noninstitutionalized disabled individuals between the ages of 21 and 64 years were employed in 2009. How much of this has to do with transportation challenges? What impact does limited and nonaccessible transportation have on the U.S. economy, especially for seniors and individuals with disabilities?

"The economic and social costs of disability are significant, but difficult to quantify," the World Health Organization report acknowledges. "They include direct and indirect costs, some borne by people with disabilities and their families and friends and employers, and some

This pedestrian signal at a crosswalk shows the current technology that requires people with vision impairments to push a button that sends a request for the traffic light to change so they can cross the intersection. New technologies, such as smartphone apps, do not require pedestrians to push a button.

People with disabilities find using automatic ticket machines, like this one at Washington DC's Reagan National Airport, to be convenient and time saving.

by society. Many of these costs arise because of inaccessible environments and could be reduced in a more inclusive setting."

When the transportation system is flexible and adaptable to universal design solutions that bolster accessibility, often the solutions evolve to benefit everyone. For example, Kalamazoo, MI, initially installed curb cuts, or sidewalk ramps, in the 1940s to make it easier for disabled World War II veterans to move around the city and reach places of employment. Eventually, cities and towns throughout the country introduced curb cuts, which have proven beneficial to bicyclists, delivery workers, people pushing strollers, and elderly populations.

David Lewis, senior vice president of the architecture and engineering firm HDR, maintains that all of the benefits of research and development into accessibility for transportation need to be quantified. For the accessibility of automatic ticket machines at airports, for example, Lewis estimates that the benefits for people with disabilities are about $330 in time savings per 100 uses versus going to a ticket agent.

"But if you include," he adds, "alongside the value of time saved, the added comfort and avoided stigmatic harm of not having to go up to a counter for assistance, the value goes up to over $700 per 100 uses. The cost-benefit analysis from [the] market point of view cannot be justified unless you take all of these other benefits into account. But when you do, you realize there's a sustainable market for accessibility out there. Ensuring sufficient investment calls for a strong research nudge, and that's what the Turner-Fairbank initiatives are all about."

Innovations in Mobile Technology and ITS

Obtaining social computing systems by crowd-sourcing from a large group of people, especially online, can benefit public transit riders, including senior citizens and those with disabilities. Researchers with Carnegie Mellon's Rehabilitation Engineering Research Center on Accessible Public Transportation have developed an iPhone® application, called Tiramisu (Italian for "pick me up"), that can predict when a bus or train operated by the Port Authority of Allegheny County in Pittsburgh, PA, will arrive. Tiramisu also makes it possible for bus and light rail riders to use their smartphones to signal in real time the vehicle's location and occupancy level.

By processing signals from onboard riders, the application can communicate to anyone whose phone has the same specialized program and who is waiting at a bus or transit stop. The signals from onboard enable prospective riders, including seniors and passengers with disabilities, to see which buses or light rail vehicles are due to arrive next and estimate how long they will have to wait. Tiramisu also can inform those in wheelchairs about available space on buses and trains. Through their phones' screen readers, blind riders can use the application as well.

Tiramisu's "universal design approach helps everyone," said Aaron Steinfeld, a senior systems scientist in Carnegie Mellon's Robotics Institute, in a 2011 press release. It can even benefit local shops, he added, "because riders will know if they have time to go into a store."

Research on V2V and V2I interaction, conducted at the TFHRC intelligent intersection shown here, could benefit travelers with disabilities.

These researchers at FHWA's Office of Operations Research and Development are using computer simulation tools to help them evaluate and develop strategies to improve transportation operations.

The U.S. Department of Transportation (USDOT) is funding ITS research that could benefit accessible transportation. Interaction between vehicles (vehicle-to-vehicle or V2V) and between vehicles and the roadway (vehicle-to-infrastructure or V2I) via communications technologies that have positioning and computing capabilities can inform travel choices, save time, and boost riders' confidence by producing a higher level of travel reliability.

FHWA is exploring the benefits of capturing and using new forms of data from automobiles, handheld devices, freight vehicles, and transit. These data will be employed in applications involving rail and roadway surfaces and infrastructure.

"We're looking at the entire transportation system, not just highways," says Joe Peters, director of FHWA's Office of Operations Research and Development. "Pedestrians, bicyclists, and those with disabilities have a particular interest in knowing when a traffic signal is going to change. We're looking at technology that will be able to tell them when the light is going to turn green or yellow or red."

In 2011, FHWA opened TFHRC's Saxton Transportation Operations Laboratory, a state-of-the-art research facility focusing on transportation-enabling technologies, innovative concepts and analysis, and operations applications. Consisting of three testbeds, the laboratory is highly integrated and offers a wide range of resources to facilitate forward-looking and reliable research. The lab's researchers are developing communications techniques for network modeling and calibration, advanced concepts for freeway merge assistance, and tests to demonstrate cooperative capabilities for adaptive cruise control and traffic signal control.

"There is a strong relationship between congestion and safety," adds Peters. "We envision a future that has connected integrated transportation systems that include bicyclists and pedestrians, which lead to increased safety, improved mobility, better air quality, and an improvement of our national productivity for all transportation system users."

Integration of Communications At Intersections

So how can messages between various products of information technology—namely, wireless communication devices and computers—be used in new ways to improve management of the transportation system? FHWA researchers are working to determine a use in the 5.9-gigahertz band for dedicated short-range communications (DSRC), which is allocated for transportation safety, but also can be used in mobility applications.

The FHWA Transportation Operations Laboratory's outdoor Cooperative Vehicle-Highway testbed intersection is equipped with systems for comprehensive control of traffic signals, DSRC, advanced detection of vehicles and pedestrians, fiber-optic communications, driver warnings with infrastructure interface, and a separate traffic signal cabinet with computers and communications devices. The DSRC system can transmit information 10 times per second to handheld mobile devices and to vehicles equipped with the dedicated short-range units.

According to Larry Head, who leads the Department of Systems and Industrial Engineering at the University of Arizona, mobile technology and ITS will be key factors in bolstering accessibility in transportation. "I think the vision is to move into a vehicle and traveler environment that is completely connected, leveraging systems that communicate with roadside equipment using many tools, including DSRC communications, 3G, 4G, Wi-Fi, and Bluetooth," he says.

Intersections, despite their complexity, are not environments that typically offer a lot of readily available information, but Head points out that if they are equipped with DSRC and public map data, "that information becomes much richer, and it becomes possible to enhance situational awareness of the position of equipped vehicles and other travelers as they report in to the intersection."

With traveler-to-vehicle and traveler-to-infrastructure communications, pedestrians with disabilities could use smartphones to initiate sequences of exchanges at intersections. "An equipped pedestrian could send a request to cross the street," explains Head. "The DSRC could then communicate this to the traffic controller. Information about the pedestrian's status and location could then be broadcast to all other travelers on the network, including approaching vehicles and emergency and transit vehicles."

Next, the intersection status technology could notify visually impaired individuals when it is safe to cross streets. "The available MAP information could also be used for

(Left) Shown is the traffic signal control cabinet at the TFHRC testbed intersection, which includes computer and communications equipment.

The onboard computer and communications equipment shown here enables interaction with the TFHRC intelligent intersection.

wayfinding," adds Head. "It can show exactly where a curb is or where the entrance to a building is located."

Other benefits of connected infrastructure communications include safety and emergency notifications, fare collection, and parking accommodations. "You could even activate the fans on a bus during the summer," says Head.

Artificial Intelligence And Machine Vision

Researchers focusing on robotics and artificial intelligence are making strides in developing products to improve the mobility and navigation of people with special needs. By 2013, the International Federation of Robotics estimates that more than 11 million personal robots will be in use around the world.

Although machine vision technologies could assist those with vision impairment to detect an obstruction or sinkhole on a sidewalk, more research is needed to provide spatial awareness and better wayfinding and guidance, both indoors and outdoors.

For military purposes, micro-inertial navigation technology (MINT)—miniaturized radar and inertial measurement units embedded in boots to track steps and locate soldiers and personnel in places with limited or no global positioning system capabilities—has been highly successful. Potentially, MINT could be combined with other technologies to help those with visual impairments navigate inside buildings.

For people with mobility impairments and for elderly individuals who use a wheelchair, cane, or crutches, signal phase and timing applications can help with crossing intersections. Using mobile communications and positioning devices, those with disabilities could broadcast their intent to cross an intersection by sending a message to roadside infrastructure that can communicate with approaching vehicles and traffic signals. As the pedestrians cross, their progress and position are tracked and processed, resulting in a command that is sent to the traffic signal and warnings that are sent to vehicles equipped with onboard communication units. If there are vehicles nearby or approaching that might cause a conflict, the red light interval can be extended to allow enough time for those with special needs to cross safely.

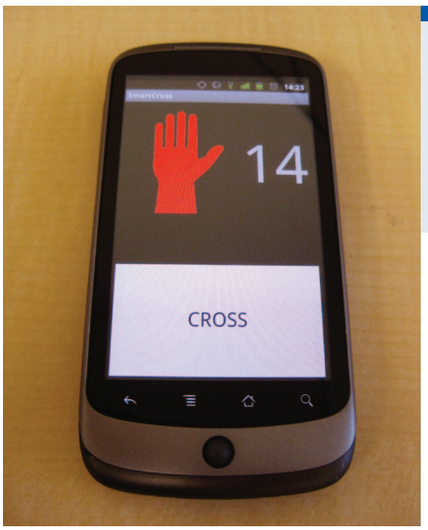
In addition, Google has developed self-driving cars that use mapping and computing resources to determine where and how fast to go. Employing lasers, radar, and cameras to assess traffic, these cars have traveled nearly 200,000 miles (321,900 kilometers) on roads in California and Nevada, according to a 2011 article in *The New York Times* written by Sebastian Thrun, a fellow at Google and research professor at Stanford University.

"Self-driving cars will be good news for the millions of Americans who are blind or have a brain injury, Alzheimer's, or Parkinson's disease," said Thrun, who works with a team of Google engineers. "Tens of millions of Americans are denied the privilege of operating motor vehicles today because of issues related to health or age. Some of these changes are far out in the future. But I envision a future in which our technology is available to everyone, in every car. I envision a future without traffic [crashes] or congestion."

Exploratory Advanced Research

In 2009 and 2010, FHWA engaged stakeholders from within and outside the traditional highway research community to identify topics of research that promise transformation and possible breakthroughs in highway technology, processes, and policies. In 2011, FHWA's Exploratory Advanced Research (EAR) Program, which focuses on long-term, high-risk research with a high payoff potential, issued a broad agency announcement to solicit research and innovations to solve critical highway challenges. The agency issued the announcement after determining that new technological solutions for wayfinding and navigation guidance for people with disabilities have a strong scientific and technical basis.

The objective of the research is to develop concepts and prototypes



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This smartphone indicates that the pedestrian using it has 14 seconds remaining to cross an intersection before the pedestrian signal will display the flashing message, "Don't Walk."

that use new technologies such as robotics, artificial intelligence, and sensors that could improve event horizons (looking ahead in time and space) related to wayfinding and navigation guidance.

The researchers will assume that broadband wireless technology, ITS, global positioning systems, DSRC, and related technologies are widely available. The concepts will be futuristic and will focus on key areas of event horizons: sensing with lasers, cameras, computer vision, robotics, artificial intelligence, or other technologies; human interfaces that decide how much information should be presented, at what time, and in what form; and algorithms that help plan an event and lay out its scope. These concepts will be flexible and extend this research to find accessible transportation solutions for the elderly and for people with sensory, cognitive, and mobility disabilities.

"Through this research, we will gain insights into providing nonvisual information and extending situational awareness that could lead to advancements in highway transportation safety and mobility for all travelers," says David Kuehn, team director of FHWA's EAR Program. "This research can lead to new sensor integration and communications systems for travelers who are blind or have sight impairments and for sighted travelers who are driving, bicycling, or walking at night or in poor visibility, while minimizing the potential distraction of having to look away from the road and toward a screen on the dashboard or on a mobile device."

So much is possible with ITS and advanced communications technologies. The hope is that the research will eventually generate a new paradigm in transportation—a system that is well-connected, versatile, and accessible to everyone, including those with disabilities.

Mohammed Yousuf is a research engineer in FHWA's Office of Operations Research and Development and, under FHWA's EAR Program, is leading research on new technology solutions for wayfinding and navigation guidance for people with vision impairments and other disabilities. As a member of the GeoAccess Challenge Team, Yousuf worked on the White House report, *Data-Enabled Travel: How Geo-Data Can Support Inclusive Transportation, Tourism, and Navigation through Communities*. Prior to joining FHWA, he worked at General Motors and Chrysler Group in vehicle product development, telematics and infotainment, and advanced service diagnostics. He has a B.S. in electronics and communication engineering from Osmania University in India and an M.S. in computer engineering from Wayne State University in Michigan.

Mark Fitzgerald is a senior communications writer at Woodward Communications, supporting FHWA's Office of Corporate Research, Technology, and Innovation Management at TFHRC. Before joining Woodward, he served as editor of several trade magazines and worked at the American Society of Civil Engineers. He has a B.A. in English from Franklin & Marshall College and an M.F.A. in creative writing from George Mason University.

For more information, contact Mohammed Yousuf at 202-493-3199 or mohammed.yousuf@dot.gov. Also see http://geoaccess.org/content/report-data-enabled-travel.

This field test is verifying that a signal phase and timing message is being broadcast using dedicated short-range communications, mounted on the white pole with the antennae. Signal phase and timing applications can help people with mobility impairments when they are crossing an intersection.

Federal-Aid Essentials

by Rob Elliott and Steve Moler

FHWA has launched a new information-sharing initiative to help your local public agency manage its highway projects.

Local roads and bridges constitute the lion's share of the Nation's vast highway network. Counties, cities, and towns—or local public agencies—own and operate 75 percent of the country's roadways—some 2.9 million miles (4.7 million kilometers). These agencies build and maintain this network using a variety of funding sources, including dollars provided through the Federal-Aid Highway Program. Of the nearly 28,000 local public agencies in the United States, each year an estimated 7,000 of them are actively managing about $7 billion in Federal-aid projects—roughly 15 percent of the total program. Projects can range from smaller ones like sidewalks and pavement overlays to larger ones that include complex interchanges and bridges.

When local public agencies receive Federal-aid funding, they work closely with their respective State departments of transportation (DOTs) to meet all Federal-aid requirements, such as those for environmental reviews, civil rights, right-of-way acquisitions, safety, and construction and contract administration. The Federal Highway Administration (FHWA) works with the State DOTs to support these agencies in their efforts to deliver their transportation projects successfully.

Locally administered projects, such as the seismic retrofit of the Golden Gate Bridge connecting San Francisco and Marin County, CA, make up about 15 percent of all Federal-aid projects nationwide. FHWA's new initiative, Federal-aid Essentials for Local Public Agencies, provides resources and training to help local public agencies comply with requirements on projects using Federal-aid dollars.

A clear understanding of the Federal-aid requirements is essential so that project staff at FHWA, State DOTs, and local public agencies can work together to complete these projects safely, on time, within budget, and while achieving a high level of quality.

In cooperation with State and local partners, FHWA recently launched a new information-sharing initiative designed to help local officials administer their Federal-aid projects more efficiently and to assist State and local agencies in attaining their project delivery goals. Known as Federal-aid Essentials for Local Public Agencies and available through FHWA's Web site, the initiative offers an abundance of information, including short videos covering numerous aspects of the Federal-aid program.

On-Demand Video Library

An important feature of the Federal-aid Essentials Web site is a resource library of about 80 informational videos and related materials. Each video focuses on a single topic in a critical area related to delivery of Federal-aid projects. The library contains relatively short (less than 10 minutes) videos, professionally narrated in nontechnical language and supported with graphics and animations that highlight the most essential content. Users can view the videos in any sequence from any computer or mobile device with Internet access.

"This cutting-edge approach puts Federal-aid essentials at the fingertips of local public agencies anytime and anywhere in the country in the most convenient way," says Bernetta Collins, director of FHWA's Resource Center. Collins and Amy Lucero, director of FHWA's Office of Technical Services, are cosponsors of the Federal-aid Essentials project. "Rather than sitting through lengthy training courses and thumbing through thick manuals, busy local public agency professionals now can view a wide range of short, informative videos from one Internet location to help them improve project delivery. After viewing the videos, they'll know where to go for additional information and how to get help."

When users first log onto the Web site at www.fhwa.dot.gov/federal-aidessentials, they can view a brief introductory video about the Federal-aid Essentials initiative and how to navigate the site. From there, they can access the resource library via a convenient drop-down menu that presents seven categories of videos: Federal-aid Program Overview; Civil Rights; Environment; Finance; Right-of-Way; Project Development; and Project Construction and Contract Administration.

Once the user selects a category, such as Environment, a menu of videos for that category appears next to the video viewing screen. Users simply click on the desired video title and the presentation begins. From the same page, users can access a number of companion materials, including a printable transcript of each video, helpful reference information, and links to additional online resources. Another function enables users to share feedback on a particular video, the resource library, or the Web site in general.

The State Resources button, located on the main page, provides access to a list of contacts at the FHWA division offices and State DOTs, as well as links to State manuals for local public agencies, the applicable sections of the Code of Federal Regulations, Local Technical Assistance Program (LTAP) centers, and other resources. Another dropdown menu on the lower part of the main page, titled "I want to know about…," helps users find information about most Federal-aid topics quickly and conveniently.

The video format is conducive to viewing in a variety of settings, including in the office, at jobsites, on mobile devices, or in meetings with project teams, stakeholders, and partners. State DOTs and local public agencies also can use the videos to augment training at the local level. When watching the videos, viewers acquire enough knowledge to know what questions to ask their State DOT counterparts, what appropriate technical terminology to use, and how and where to access additional assistance.

"I think this is a great idea," says Alan Chapman, deputy director for program delivery in Gwinnett County, GA. "In the past, information about Federal-aid requirements tended to be fragmented in many different places. Thanks to this innovative approach, we can get everything we need in one location. These videos and the companion materials greatly

Gwinnett County (GA) Department of Transportation

Local public agencies administer a wide range of projects, from complex interchanges to simpler pedestrian improvements. Here, workers are building sidewalks and a multiuse path to tie the Gwinnett Center and Arena outside Atlanta, GA, to nearby retail, entertainment, and lodging businesses. The path also will provide pedestrian access under I–85 to a shopping mall and mass transit station.

An inspector for the Puerto Rico Highway and Transportation Authority samples hot-mix asphalt from a truck for use in acceptance testing. Quality assurance is critical to meeting Federal and State requirements and is among the topics covered in the Federal-aid Essentials initiative.

The Camino Real Regional Mobility Authority used about $96 million in American Recovery and Reinvestment Act funds, or about two-thirds of the total project cost, to improve the often congested interchange that connects the Ysleta-Zaragoza Bridge, at the U.S.-Mexico border in El Paso, TX, to I–10 via Loop 375.

improve communications and give those of us at the local level current and accurate information."

How the Initiative Was Conceived

The need for a central information resource for the Federal-aid program surfaced after a series of FHWA internal reviews and risk assessments revealed gaps in local public agency oversight of projects, which resulted in some instances of noncompliance at the local level. One significant issue was delivering accurate information about Federal-aid requirements to the local roads community. Most information about the Federal-aid program had been scattered among various Web sites and manuals. The transportation community needed a central repository of fundamental policies, procedures, and guidance.

In early 2011, FHWA officials formed a development team for the Federal-aid Essentials project. The team came up with the concept of creating an innovative delivery system addressing key Federal-aid concerns that would target a vast audience, provide concise and consistent information, and be available on demand.

At first, FHWA developed self-paced, Web-based training modules, but early prototypes proved too long and complicated. The team then shifted focus to an information-sharing Web site and resource library concept based loosely on the Khan Academy, a nonprofit educational organization that offers some 3,000 brief instructional videos posted online covering subjects ranging from mathematics and science to finance and history.

"I had been using the Khan Academy model in preparing some of my other FHWA training courses," says Michael Smith, a project management engineer with the FHWA Resource Center. "I showed it to the project development team's leadership, and they liked it so much, they decided to run with the idea."

FHWA next assembled a larger team of subject matter experts, content managers, script writers, and production specialists to create the videos. Each video had to meet several requirements: It had to be fairly short, cover a single important topic within the Federal-aid program, provide only the most essential information, display easy-to-understand visuals, and be narrated in nontechnical language. All videos were subjected to rigorous policy and legal reviews within FHWA to ensure accuracy of content and proper interpretation of the relevant sections within the Code of Federal Regulations.

Meeting Local Needs

To ensure that the videos would meet the needs of local public agencies, FHWA initiated a series of activities to assess the quality and utility of the Federal-aid Essentials materials and obtain feedback from various State and local roads representatives. In November 2011, during the project's early development, FHWA formed a focus group of six representatives from local public agencies selected from across the country,

Sample Topics in the Video Library

Federal-aid Program Overview	• Stewardship and Oversight • A Process from "Cradle to Grave" • Key Actions in the Cradle-to-Grave Process • Funding Basics and Eligibility • Project Requirements	• National Bridge Inspection Standards • Consultant Services Overview • Hiring a Consultant Using Competitive Negotiation Procedures • Organizational and Consultant Conflicts of Interest
Civil Rights	• Background and Purpose • Nondiscrimination Requirements on Construction Contracts • Foundations of the ADA/Section 504	• Transition Plans • Self-Evaluation Basics • DBE Program Overview
Environment	• Overview of NEPA as Applied to Transportation Projects • Documentation and the Environmental Process • NEPA Compliance and Class of Actions • Categorical Exclusion • Environmental Impact Statement • Environmental Assessment	• Purpose & Need, and Alternatives • Public Involvement • Agency Coordination • Mitigation of Environmental Impacts and Environmental Commitment Compliance
Finance	• Introduction to Cost Principles • Common Grant Rule • Transparency Act Sub Award Reporting • Internal Control Regulations and Requirements • Introduction to Internal Control	• Single Audit (OMB Circular A-133) • Developing an Indirect Cost Allocation Plan • Matching or Cost-Sharing Requirements • Advance Construction
Right-of-Way	• Introduction to Right-of-Way Requirements and the Uniform Act • Project Development • Property Management	• Valuation • Acquisition and Negotiation • Relocation Assistance
Project Development	• Projects and Statewide Planning Requirements • Cost Effectiveness Determinations and Public Interest Findings • Selecting the Method of Construction: Contract or Force Account • Project Advertisement, Bid Review, and Request for Concurrence in Award • Project Geometric Design Requirements	• Environmental Requirements • Value Engineering Requirements for Federal-aid Projects • Bike and Pedestrian Accommodation • Pedestrian Accessible Design Requirements • Form FHWA-1273
Project Construction and Contract Administration	• Introduction to Project Construction and Contract Administration • Supervising Agency Requirements • Construction Quality Assurance • Design-Build Procurement • Project Closeout	• Contract Time and Schedule Management • Change Orders • Buy America Field Compliance • Job Site Posters

two staffers from State DOTs, and two representatives from the Local and Tribal Technical Assistance Programs (LTAP-TTAP). The latter is a national network of 58 centers that delivers training, information, and technical assistance to the local roads community. The members of the focus group answered questions about their past Federal-aid experiences and future needs, and how they might use the Federal-aid Essentials Web site. The focus group also provided feedback on sample videos.

"We were very interested in the videos because they were targeted," says Georgia's Chapman, a focus group participant. "If you have a specific issue, you can go straight to the Web site, find the video you need, and learn what to do, whom to contact, and how to move forward. I see the video library as a day-to-day resource—it's immediate information that you can get in the field, and you don't have to interrupt a project. You can find answers quickly and keep moving."

After viewing some of the earlier videos, Donna Shea, director of Connecticut's LTAP center, found the resource library to be a convenient way to distribute educational materials to local transportation officials. "The [videos] are cleverly done so that they're short, concise, and easy to understand. We're excited to get them," she says.

In fact, the Connecticut LTAP center liked the Federal-aid Essentials initiative so much that it formed a statewide team of representatives from FHWA's Connecticut Division Office, the Connecticut Department of Transportation, metropolitan planning organizations, and local

Al Fausto, City of Chandler, AZ

This locally administered Federal-aid project in Chandler, AZ, involved rehabilitating a 1.5-mile (2.4-kilometer) section of Price Road in an area populated by business parks and manufacturing facilities.

Jim Phipps, City of Chandler, AZ

The city of Chandler, AZ, combined Federal-aid and State Highway Safety Improvement Program funds for this $7.1 million intersection widening project. Work included construction of dual left-turn lanes, a third auxiliary through-lane, right-turn lanes, bike lanes, bus pullouts, medians, street lights, and landscaping.

public agencies to evaluate ways to integrate additional training materials with the Federal-aid Essentials program. As a result of the team's discussions, the Connecticut LTAP is developing a new section on its Web site that integrates the Federal-aid Essentials resource library with customized Connecticut-specific videos and other resources, such as examples of successful projects, funding sources, key contacts, and frequently asked questions and answers.

Compiling Feedback

In addition to the feedback from the focus group, FHWA solicited input from an internal leadership group known as the Office of Technical Services Advisory Group, which provided the project development team with general guidance on how to best meet State DOT and local public agency needs. The advisory group vetted the initiative's original implementation plan, critiqued some of the earlier videos, and provided suggestions for a simple, conversational language style as well as insights that led to the inclusion of companion materials.

FHWA used information from the focus group, advisory group, and internal reviews and risk assessments to determine the seven video categories. Specific videos within each category were developed to address many aspects of the Federal-aid program, including such topics as disadvantaged business enterprises, the Americans with Disabilities Act, project closeout, Buy America Act, quality assurance, value engineering, the National Environmental Policy Act, and internal financial controls, to name a few. Each video can be updated if needed, and new videos will be added over time to accommodate new policies and regulations and to meet State DOT and local public agency needs.

As the summer 2012 launch date neared, FHWA continued to engage State and local partners in refining and improving the initiative's materials. For example, FHWA sponsored four townhall webinars during which 145 representatives of local public agencies, LTAPs, and national transportation organizations reviewed and provided feedback on the Federal-aid Essentials materials.

"You've got to have reliable and accurate resources to go to," says Lewis Cooksey, a focus group participant and transportation project manager in Gwinnett County, GA. "You've got to be able to sort out facts from opinions. The Federal-aid Essentials program helps us accomplish this and reach consistency in interpreting the Federal regulations."

A worker finishes bridge deck concrete on the McGinnis Ferry Road extension, a Federal-aid project involving a 1.6-mile (2.6-kilometer) bypass to the Lawrenceville-Suwanee Road interchange with I–85 in Gwinnett County, GA. The county supplied funding for the planning, engineering, land acquisition, utility relocations, and environmental mitigation, while the Georgia Department of Transportation used $20.4 million in Federal-aid and State funding to construct the project.

Gwinnett County (GA) Department of Transportation

States Give Additional Support

State DOTs also have taken steps in addition to the Federal-aid Essentials initiative to help local public agencies manage their Federal-aid projects. Some States have ramped up training, including starting or upgrading certification programs that are helping local public agencies meet minimum requirements for administration of Federal-aid projects. States also have implemented local stewardship agreements that clarify roles and responsibilities and ensure proper monitoring of projects.

Some States also have updated or published new guidance manuals for local public agencies. The manuals now are accessible as companion materials on the Federal-aid Essentials Web site. Further, some States are encouraging local public agencies to use checklists for tracking project milestones and to hold early and frequent project meetings. The Nebraska Department of Roads (NDOR), for example, recently put several improvements in place, including updating and expanding its *LPA Guidelines Manual for Federal-Aid Projects*, developing checklists for each Federal-aid focus area, and delivering classroom and Web-based training. NDOR also revamped its Web site to improve access to information and guidance on State and Federal regulations, including State stewardship agreements, downloadable forms, and guidelines for disadvantaged business enterprises.

"We have more than 125 local public agencies in our State, and oversight has definitely been a challenge," says Anthony Dirks, an urban transportation engineer in NDOR's Local Projects Division. "Expertise varies widely from one local public agency to another, so we started putting initiatives in place to help get more consistency with both State and Federal compliance."

The Federal-aid Essentials initiative and recent State DOT efforts are steps toward helping the transportation community pursue better, faster, and smarter ways of delivering the Federal-aid program, with the overall goal of ensuring a strong, safe infrastructure serving the public interest.

Rob Elliott is the team manager for the Construction and Project Management Technical Service Team in the FHWA Resource Center and has served as project manager for the Federal-aid Essentials project development team. He joined FHWA in 2003 and has worked in construction operations, contract administration, innovative contracting, construction inspection and oversight, construction training, specifications, and cost estimations. Previously he worked for 11 years with the Florida Department of Transportation. Elliott holds a B.S. in civil engineering from Auburn University.

Steve Moler is a public affairs specialist in FHWA's Office of Public Affairs, Office of Public Communications. He has been with FHWA since 2001, assisting the agency's field offices and partners with media relations, public relations, and public involvement communications. He has a B.S. in journalism from the University of Colorado at Boulder.

For more information, visit www.fhwa.dot.gov/federal-aidessentials or contact Rob Elliott at 404-562-3941 or rob.elliott@dot.gov or Carin Michel at 410-962-2530 or carin.michel@dot.gov.

Maricopa County, AZ, combined $1.5 million in Federal-aid funds with $3 million from Arizona Highway User Revenue Funds to rehabilitate the historic Gillespie Dam Bridge, shown here prior to enhancements, over the Gila River. The agency also used the funds to construct the Gillespie Dam Bridge Interpretive Plaza. Constructed in 1927, the 13-span steel truss bridge was part of the national "Ocean-to-Ocean Highway" until decommissioned as an interstate route in 1956. The project was awarded the prestigious Arizona Centennial Legacy Project designation.

Roberta Crowe, Maricopa County (AZ) Department of Transportation

Making Walking Safer for Arizonans

by Kohinoor Kar and Mike Cynecki

An FHWA focus State speaks out about enhancing pedestrian safety through various innovations, including improved midblock crossings on multilane roads.

Pedestrian safety is a vital concern to State and local transportation agencies because of the severity of vehicle crashes that involve walkers. In Arizona, pedestrian-vehicle collisions comprise only 1 to 2 percent of total traffic crashes, whereas 13 to 20 percent of the traffic fatalities in recent years were pedestrians.

Achieving safe conditions for pedestrians (and eliminating crashes involving them) is especially challenging in urban and suburban areas with multilane roads and high speeds. Nationally, pedestrian fatalities are far more common in urban localities than in rural areas, often representing 25 to 40 percent of the total traffic fatalities.

One of the most significant challenges is improving the safety of midblock crossings on multilane roads. Crossings on roads with more than one lane in each direction involve a multiple-threat condition, where a motorist stopped for a crossing pedestrian creates a visual screen, blocking the view of motorists in adjacent lanes.

Although concern for pedestrian safety is paramount, almost equally important is a desire to make communities more walkable to promote healthy habits among residents and to help reverse the Nation's rising obesity trend. Walking is the most universal form of transportation, and walkable neighborhoods can add to a metropolitan area's economic vitality because of commercial activity by pedestrians, including shopping, dining, banking, job access, etc. Moreover, walking is environmentally friendly because it eliminates the need to use energy produced by fossil fuels.

In 2003, the Federal Highway Administration (FHWA) identified Arizona as 1 of 13 pedestrian focus States and Phoenix as 1 of 5 focus cities. FHWA listed as focus States those with 150 or more pedestrian fatalities per year and a pedestrian fatality rate above the national average rate of 2.5 per 100,000 population. Focus cities were those with the highest total pedestrian fatalities. Accordingly, FHWA established a strategy to develop and implement pedestrian safety action plans in the focus States. (See "Spotlight on Pedestrian Safety" in the January/February 2012 issue of PUBLIC ROADS

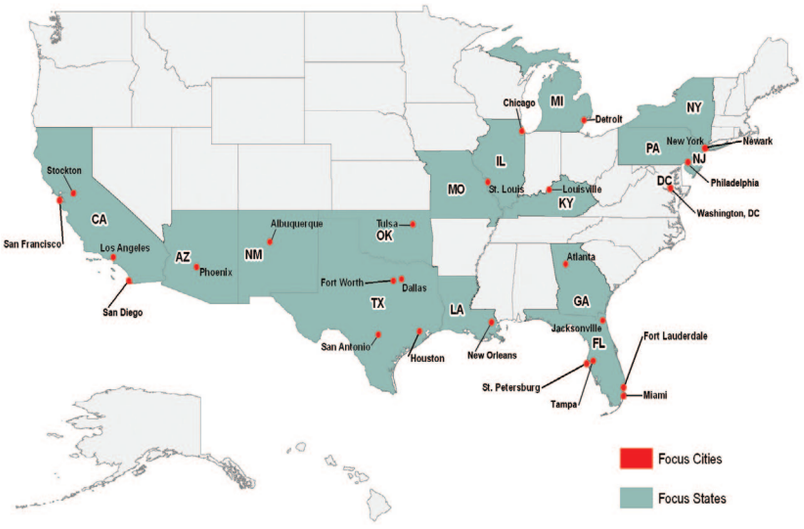
(Above) This wide-angle photo shows a pedestrian crossing in Phoenix, AZ, with back-to-back rectangular rapid flashing beacon (RRFB) units installed on the median and at each side of the crossing. RRFB units are one of several strategies Arizona is using in its efforts to improve safety for pedestrians. *Photo: Mike Cynecki.*

and "Focusing on Pedestrian Safety" in the May/June 2008 issue.)

In 2007, after reviewing more current crash data, FHWA revisited its criteria for identifying focus States and cities. Four cities stayed on the list at that time: Chicago, IL; Los Angeles, CA; New York, NY; and Phoenix, AZ. Later, Washington, DC, was added and Detroit, MI, dropped off and then came back on again in 2011 when FHWA significantly modified the criteria for identifying focus cities and States.

The 2011 criteria for cities included having an average of 20 or more pedestrian fatalities per year over a 3-year period or a pedestrian fatality rate higher than 2.33 per 100,000 population. Focus States became those that contain a focus city. As a result, FHWA identified several additional focus cities and designated their States as focus States. Phoenix and Arizona stayed on the list because Phoenix continued to experience high pedestrian fatalities, primarily due to a large number of wide, high-speed roadways. Although those roads carry large volumes of traffic efficiently, they are not pedestrian-friendly, and those conditions cannot be easily changed.

FHWA Pedestrian Focus States and Cities in 2011



Source: FHWA.

The Arizona Response

The Arizona Department of Transportation (ADOT) responded to its FHWA designation as a focus State with the formation of a statewide pedestrian safety group including representatives from Federal, State, regional, and local agencies to discuss the issues and develop action plans.

With support from FHWA, ADOT held four workshops related to pedestrian safety—one in Flagstaff, two in Phoenix, and one in Tucson between 2006 and 2007. Then in April 2007, ADOT developed an Arizona-specific supplement to the FHWA guide, *How to Develop a Pedestrian Safety Action Plan* (FHWA-SA-05-12).

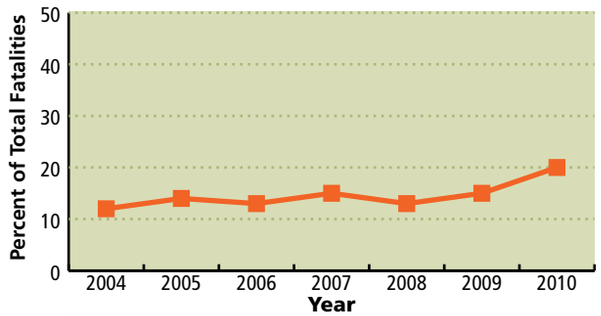
In accordance with a requirement under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Arizona developed a Strategic Highway Safety Plan in August 2007. The Arizona plan includes six emphasis areas based on analysis of statewide crash data: restraint usage, young drivers, speeding, impaired driving, roadway/roadside (lane departures and intersections), and data improvement. Although pedestrian safety was not one of the emphasis areas, countermeasures proposed under "intersections" include considerations for pedestrians.

A recent statewide trend analysis by ADOT showed, however, that pedestrian fatalities have become a slightly larger proportion of total traffic fatalities in Arizona. In 2007, there were 157 pedestrians killed in crashes on streets and highways in Arizona, which is 15 percent of all traffic fatalities that year. The years 2008 and 2009 experienced a marked reduction in the *number* of Arizona's pedestrian fatalities. But due to a

ADOT

Shown is State Route 179 in the Sedona area after implementation of roadway improvements accommodating pedestrians.

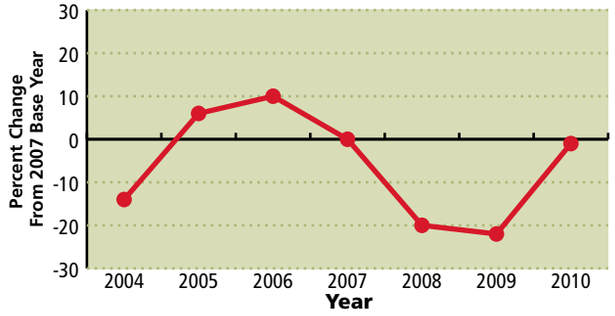
Arizona's Pedestrian Fatalities, 2004–2010



Fatalities	135	166	172	157	125	122	155
Percent Total	12	14	13	15	13	15	20

Source: ADOT, Traffic Safety Section.

Changes in Arizona's Pedestrian Fatalities from 2007 Base Year



Fatalities	135	166	172	157	125	122	155
Percent Change	-14	6	10	0	-20	-22	-1

Source: ADOT, Traffic Safety Section.

reduction in the State's total number of traffic fatalities during those years, the *percentage* of pedestrian fatalities remained almost unchanged (13 percent of all traffic fatalities in 2008 and 15 percent in 2009). The exact reasons for the overall reduction are unknown, but reduced vehicle miles traveled due to the economic downturn could be partially responsible. Engineering enhancements and vehicle technologies, coupled with education, enforcement, emergency responses, and legislative changes, could have contributed.

Unfortunately, in 2010, pedestrian deaths accounted for 155 fatalities, which is almost the same number as in the 2007 base year (the year selected in the Arizona Strategic Highway Safety Plan). It also represents a higher percentage (20 percent) of the total statewide fatalities during that same time period, due in part to the overall significant decline in the total number of traffic fatalities. Data from Phoenix show a similar trend of pedestrian fatalities.

In 2009, ADOT developed a *Pedestrian Safety Action Plan* (PSAP) to address pedestrian safety issues along the State highway system, including safety issues at segments and intersections exclusively maintained and operated by ADOT, as well as at State segments overseen under joint agreements with local jurisdictions. Based on a safety analysis included in the PSAP, the State identified critical locations requiring further investigation.

The State PSAP recommends some incremental steps that will make it easier to implement complete streets concepts that make roads safer for all users. The needs for pedestrians were accommodated, for example, in a roadway project along State Route 179 between the village of Oak Creek and Sedona. *What Moves You Arizona: Long-Range Transportation Plan 2010–2035,* published in November 2011, includes specific recommendations on complete streets and context sensitive solutions.

From 2004 through 2010, Phoenix alone had more than 30 percent of statewide pedestrian fatalities. The city's Street Transportation Department developed a draft PSAP as well. The city currently is implementing the provisions contained in that PSAP.

Implementing Pedestrian Safety Improvements

ADOT and county and city road agencies already were working to improve pedestrian safety even before the State transportation agency developed its own PSAP. Actually, ADOT was conducting Road Safety Assessments (RSAs) and existing programs such as the Highway Safety Improvement Program, Safe Routes to School program, Transportation

Mike Cynecki

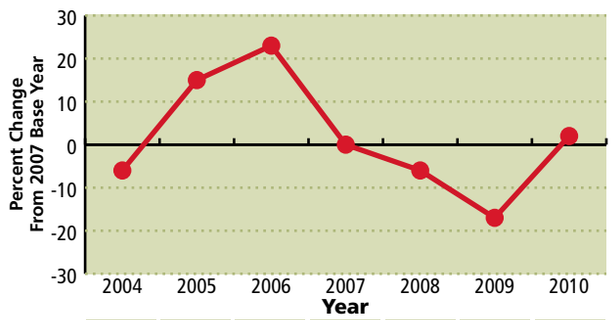
Pendergast Elementary School in Phoenix had one of the highest turnouts of students and parents for their Walk to School event. One of the students shown here was overheard to say to another, "We're helping to save the planet."

Phoenix's Pedestrian Fatalities, 2004–2010

Fatalities	44	54	58	47	44	39	48
Percent Total	24	26	26	24	29	25	32

Source: ADOT, Traffic Safety Section.

Changes in Phoenix's Pedestrian Fatalities from 2007 Base Year



Fatalities	44	54	58	47	44	39	48
Percent Change	-6	15	23	0	-6	-17	2

Source: ADOT, Traffic Safety Section.

Enhancement activities, and the Congestion Mitigation and Air Quality Improvement program (in the Phoenix metropolitan area), which provided funding for pedestrian safety projects. Since 2009, ADOT also has had an initiative to adopt an internal complete streets policy.

The Highway Safety Improvement Program (HSIP) is the umbrella Federal program that primarily addresses infrastructure safety issues. HSIP can fund a variety of pedestrian safety projects, provided certain eligibility requirements are met. Several location-specific and systematic improvement projects on all public roads (for example, State highway systems and local road facilities) specifically address pedestrian safety issues.

The Road Safety Assessments (also known in some States as Road Safety Audits) are formal examinations of user safety on future or existing roadways by independent multidisciplinary teams. The RSA program is a well-established tool in Arizona with several statewide pedestrian assessments conducted to date.

A common finding of the RSAs performed on tribal reservations is the high percentage of fatal pedestrian crashes. For example, a safety assessment on State Route 73 through the White Mountain Apache Reservation found that 36 percent of the fatal crashes on the highway involved pedestrians, with 89 percent of the pedestrian crashes occurring at night.

"This percentage is quite high for a rural area," says Mike Blankenship, the ADOT program manager for RSAs. To improve safety for pedestrians on the reservation, the RSA team recommended installing improved street lighting and enhanced crossings.

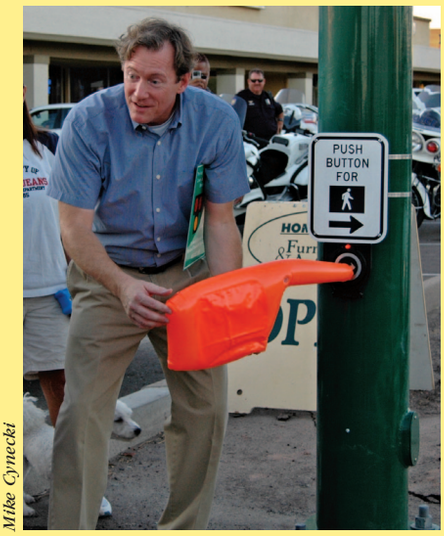
"Numerous pedestrian safety projects (such as installing pedestrian hybrid beacons and countdown signals, and improving street lighting) were developed and implemented after RSAs were conducted throughout the State," says Blankenship.

Arizona's Safe Routes to School program provides funding to develop projects to address infrastructure and noninfrastructure needs. Examples of the former include construction of new sidewalks and installation of a pedestrian hybrid beacon at a school crossing. Examples of addressing noninfrastructure needs include implementing educational curricula, encouragement measures such as prize giveaways, and enforcement steps such as school crossing guard STOP paddles, safety vests, and hats. Eligible funding applicants include schools, school districts, municipalities, and tribal communities.

Safe Routes to School education and funding continues to be an important priority in Arizona. In 2005, the program participated in the first national instructor training course in Tucson, developed by the Pedestrian and Bicycle Information Center and now run by the National Center for Safe Routes to School, and has since offered additional instructor trainings in Flagstaff and Phoenix.

Although International Walk to School Day is celebrated throughout the State, Phoenix implemented Walk to School Month to accommodate 27 separate walk-to-school events in 2011. The events were preceded by school assemblies for educating students on the importance of pedestrian safety and walking as a healthy lifestyle choice. The city and schools encouraged student participation through the use of poster and essay contests on pedestrian safety. The total participation included 5,000 participants who walked to school and 20,000 students who attended the assemblies.

Phoenix continues to reach out to pedestrians and pedestrian organizations through the Mayor's Commission on Disability Issues and neighborhood associations, and receives feedback from individual citizens. The mayor's commission was the prime motivator for recent changes to the Phoenix *Traffic Barricade Manual* and adoption of a right-of-way management ordinance to better protect the rights of access for pedestrians and vehicles and safety in construction zones. The Right-of-Way Management Program added certification in traffic control for construction zones and the ability to impose fines if sidewalks and streets are improperly blocked or unsafe conditions for pedestrians and drivers occur during construction or maintenance activities. The city also added new inspectors. Neighborhood organizations have been the primary advocates for pedestrians and were responsible for the implementation of the first road diet projects in



Mike Cynecki

(Above) Phoenix Councilman Tom Simplot ceremonially activates the city's first pedestrian hybrid beacon (formerly known as the HAWK) at 7th Avenue and Glenrosa Avenue.

(Below) Dr. Richard Nassi, who developed and installed several High-intensity Activated crossWalK (HAWK) beacons (now known as the pedestrian hybrid beacon), is crossing an intersection in Tucson, AZ, where one of the devices is installed.

Mike Cynecki

Phoenix, largely to make the neighborhoods safer and more walkable.

A number of projects provide pedestrian safety improvements through Transportation Enhancement grants, such as the Bicycle Pedestrian Statewide Safety Education Project sponsored by Valley Metro, the public transit provider for the Phoenix metropolitan region.

Highlights of New Safety Tools

Arizona is no stranger to developing and implementing pedestrian safety improvements. For example, Tucson was the birthplace of the High-intensity Activated crossWalK, or HAWK. City traffic engineer Richard Nassi (retired from Tucson but currently working for the Pima Association of Governments) first developed the HAWK, based on a similar concept seen in Europe. Nassi wanted to assist pedestrians crossing busy, higher speed multilane streets, without requiring traffic signals to be installed. Traffic signals are expensive and can lead to unintended negative consequences, such as higher numbers of motor vehicle crashes and vehicular and pedestrian delays.

Nassi's idea was to develop a new traffic control device that would provide greater responsiveness to pedestrians while minimizing delay to motor vehicle traffic at midblock and minor street crossings. The city of Tucson did extensive field testing with the HAWK, and FHWA eventually adopted it for inclusion into the national 2009 *Manual on Uniform Traffic Control Devices* as the pedestrian hybrid beacon.

The device features two red light indications located above a single yellow light. The beacon indications are dark to motorists unless activated by a pedestrian. Extensive testing by the Texas Transportation Institute using comparison sites and before-and-after Empirical Bayes evaluations found that pedestrian hybrid beacons not only reduced pedestrian crashes, but also reduced total vehicle crashes.

Tucson and agencies in the adjacent metropolitan area have installed more than 100 of these devices since their inception in 2000. In addition, Phoenix has installed 12 of the beacons since 2009, and 2

Kobinoor Kar

Shown is the mast arm sign for the pedestrian hybrid beacon at the intersection of 7th Avenue and Glenrosa Avenue in Phoenix.

Mike Cynecki

This student marching band from Sunnyslope High School in Phoenix is performing during a celebration of the activation of a new pedestrian hybrid beacon.

more currently are under design; Scottsdale has installed 4; and Glendale, Mesa, Peoria, and Tempe also have installed a few. For safer pedestrian crossing, ADOT has installed its first pedestrian hybrid beacon on U.S. 60 in Globe and is in the process of installing one on State Route 95 in Bullhead City. Scottsdale also installed a modified version of a two-stage crossing with a pedestrian hybrid beacon that separates pedestrians crossing from each direction of travel.

In addition to pedestrian hybrid beacons, Tucson has installed a two-stage PEdestrian LIght Control ActivatioN (PELICAN) pedestrian signal along an arterial street. The PELICAN permits pedestrians to cross each direction of vehicular travel separately by first crossing to a central median island. Traffic synchronization is maintained in both directions.

Other pedestrian innovations in Tucson are the TwO groUps CAN (TOUCAN) crossing. In a TOUCAN crossing, two groups (pedestrians and bicyclists) cross side by side using separate pedestrian and bicycle signal indicators. In addition, a pedestrian crossing extension using a microwave detector determines whether pedestrians need additional crossing time.

Phoenix was the first city in Arizona to implement the rectangular rapid flashing beacon (RRFB) at two crossings near schools. This device features a flashing pattern that is similar to the pattern used on emergency vehicles. Experiments in Florida have shown this device to be far more effective than standard flashing warning devices.

Initial evaluations in Phoenix confirmed that the yield rate by motor vehicles is much higher than it is for a standard yellow beacon or the in-pavement flashing warning lights that the RRFB replaced. However, Phoenix determined that education and monitoring are needed to ensure that more pedestrians push the button before crossing. Recently, Flagstaff has announced plans to provide RRFBs at two crossing locations, and additional municipal agencies in Arizona are considering their implementation.

In recent years, other innovations in Phoenix include the two-stage crossing, in which pedestrians cross halfway to a central median island and then face approaching traffic once they reach the island before crossing the second half of the street. Two-stage crossing islands are most appropriate at midblock crossings of multilane streets with high pedestrian activity. Unlike the PELICAN two-stage, signal-controlled crossing, the Phoenix two-stage crosswalks operate without traffic signals.

Phoenix installed its first two-stage crossing in 2006 in direct response to an FHWA workshop on pedestrian safety in the same year. The crossing is at the 3200 block of West Van Buren Street, where it facilitates access between

Mike Cynecki

At a two-stage crossing governed by a pedestrian hybrid beacon, these pedestrians are crossing the first stage to a central island. The crossing connects shopping centers on both sides of Scottsdale Road in Scottsdale, AZ.

Mike Cynecki

Shown here is a PEdestrian LIght Control Activa-tioN (PELICAN) crossing—a two-stage pedestrian signal-actuated crossing—at the University of Arizona Medical Center in Tucson, AZ.

a residential neighborhood and the Carl Hayden Community Center on the opposite side of a multilane arterial. Residents of the neighborhood were so pleased with the pedestrian enhancement that the Phoenix Street Transportation Department received an award from Chicanos por la Causa, a national consortium of nonprofit developers of affordable housing. Since that time, Phoenix has constructed several other two-stage crossings across multilane arterial streets.

Summing Up

In recent years, ADOT and several municipal agencies in Arizona have undertaken initiatives to evaluate pedestrian safety issues and implemented innovative solutions, such as the pedestrian hybrid beacon, rectangular rapid flashing beacon, and two-stage crossing.

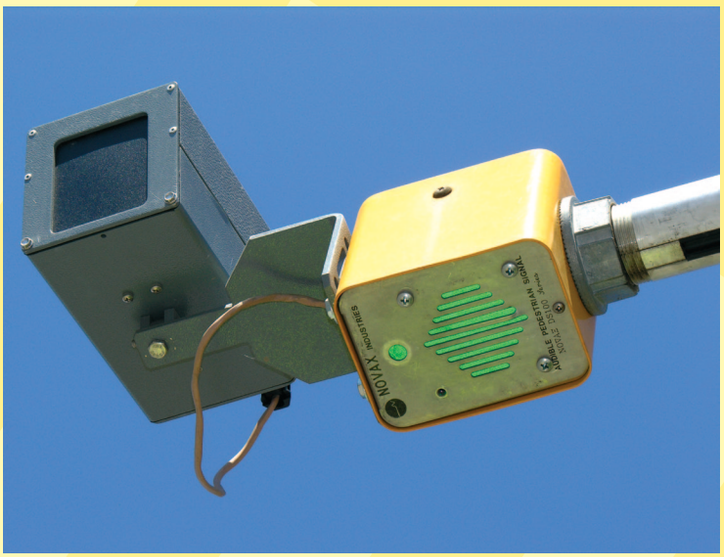
Since 2009, Phoenix has converted more than 62 percent of its pedestrian signals to countdown signals, in a system containing 1,097 signalized locations. In addition, the city has requested Federal funding for assistance in converting the remaining pedestrian signals to add the countdown feature. Arizona is using a portion of its Highway Safety Improvement Program funding for installation of countdown pedestrian signal heads throughout the State.

These systematic improvements help provide pedestrians with substantial safety benefits. Although infrastructure improvements have the potential to reduce pedestrian

Mike Cynecki

(Left) At this TwO GroUps CAN (TOUCAN) crossing in Tucson, AZ, two groups (pedestrians and bicyclists) can cross side by side.

(Below) This microwave detector in Tucson, AZ, provides additional crossing time for slower pedestrians.



Mike Cynecki

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This city worker is crossing at an intersection where the first rectangular rapid flash beacon in Arizona was installed, near the Paradise Valley High School in Phoenix.

fatalities and injuries, nonengineering countermeasures, such as education and enforcement, can play a vital role where driver and pedestrian behavioral factors contribute significantly.

Securing funding in a competitive environment (especially during a tight economy) and completing all of the processes involved in executing these types of projects can take anywhere from 1 year to several years. Implementing systematic safety improvements that involve limited environmental impacts is one way to streamline project development and funding.

Although total traffic fatalities in Arizona declined by 30 percent between 2007 and 2010, pedestrian fatalities have not experienced the same decline, indicating more work remains. When updating its Strategic Highway Safety Plan, Arizona will increase emphasis on pedestrian safety. State and municipal agencies have expressed a willingness to continue to explore further pedestrian safety treatments and funding for implementing those treatments.

"Based on our analysis of crash data from 2010, we have experienced large drops in the number of traffic fatalities since adopting the State's Strategic Highway Safety Plan in 2007," says Mark Poppe, State safety engineer. "Unfortunately, we have not seen the same type of declines in pedestrian fatalities. I would like to see continued emphasis on pedestrian safety, working with [our] traffic safety partners across Arizona as we address this critical issue."

Kohinoor Kar, Ph.D., P.E., PTOE, a professional engineer with 23 years of combined experience in the roadway, traffic and safety field, has been with ADOT for 8 years. He has published research papers in refereed journals and presented at several conferences. Kar serves on a number of safety-related advisory committees at the State, national, and international levels. He has a Ph.D. in civil engineering from Wayne State University.

Michael J. Cynecki, P.E., retired from the Phoenix Street Transportation Department in 2011 after a career of 26 years and currently is with the consulting firm of Lee Engineering, LLC. He serves as chair of Transportation Research Board Section ANF00, which includes the pedestrian, bicycle, and motorcycle committees, and also is involved in Safe Routes to School training. He has B.S. and M.S. degrees in civil engineering from Wayne State University.

Disclaimer: Information or opinions presented in this article are those of the authors or references cited herein and do not necessarily represent the views of the agencies they are affiliated with.

The authors gratefully acknowledge the resources and support provided by FHWA's Office of Safety, Resource Center, and Arizona Division Office to help address pedestrian safety issues in Arizona. The authors also are grateful for helpful input provided by ADOT Bicycle/Pedestrian Coordinator Michael Sanders.

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Mike Cynecki

This two-stage crossing at East McDowell Road in Phoenix provides a safer connection between offices for a medical business that is located on both sides of a busy multilane arterial.

Two Pennsylvania bridge replacements illustrate techniques for complying with NEPA while delivering small-scale projects efficiently. Here are six steps from a design perspective.

Expediting Environmental Approvals

by Kevin J. Starner

All projects funded by the Federal Highway Administration (FHWA) or requiring FHWA approvals need to comply with the National Environmental Policy Act (NEPA) process. NEPA involves consideration of the potential for impacts on a number of resources that are protected to some extent by other laws under the NEPA umbrella, including wetlands and watercourses, threatened and endangered species, noise and air quality, and cultural resources. Other concerns include flood plain encroachments, farmland takings, hazardous and residual waste sites, socioeconomic impacts, and provisions related to Section 4(f) of the Department of Transportation Act of 1966.

Section 4(f) states that FHWA and State departments of transportation (DOTs) cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless there is no feasible and prudent alternative to the use of that land and the action includes all possible planning to minimize harm to the property resulting from use.

The NEPA process requires the balancing of a project's benefits with its environmental impacts to achieve informed governmental decisionmaking. The law does offer various paths for clearance of a project, depending on the scope and intensity of its impacts on various resources, the level of public and agency controversy, and the project's consistency with other Federal, State, and local laws. A review of its purpose and need should compare the project's overall public interest to the challenge of the impacted community's enduring negative effects. Some projects require extensive environmental analyses, plus disclosure and negotiation with stakeholders, documented in an environmental impact statement. Other projects may not require as extensive documentation.

"A significant percentage of transportation investments are small-scale rehabilitation and reconstruction projects aimed at preserving the existing network," says Sharon Okin, environmental manager, PennDOT Engineering District 8-0. "By their nature, these projects are categorically excluded from the requirements to prepare an environmental impact statement because, based on experience, such projects do not result in significant environmental impacts."

Categorical Exclusions are actions that meet the definition contained in the Code of Federal Regulations (23 CFR § 771.117). Based on past experience with similar actions, they do not involve significant environmental impacts to planned growth or land use; do not require the relocation of significant numbers of people; do not have a significant impact on any natural, cultural, recreational, historic, or other resources, do not involve significant air, noise, or water quality impacts; do not have significant impacts on travel patterns; and do not otherwise, either individually or cumulatively, have any significant environmental impacts.

The topography and history of Pennsylvania created potential complexities for even minor projects. Topography dictated Native American and European settlement patterns, resulting in historic and archaeological sites that require careful consideration during bridge replacements. Although most rehabilitation

(Above) Field views like this one conducted near Gettysburg, PA, are part of an effective project scoping process. *Photo: Kevin Starner, Skelly and Loy.*

and reconstruction projects might be fairly benign from an environmental perspective, occasional projects are located in ecologically distinctive or sensitive settings or involve unusual circumstances that result in environmental impacts.

These projects generally require case-by-case agency coordination, field studies, and environmental analyses to identify and resolve project-specific issues. In some cases, environmental complexities are not fully recognized or understood at the outset, resulting in an inadequate scope of work or an unrealistic schedule for delivering the project.

To illustrate key techniques for delivering these small-scale, environmentally challenging projects in a timely and efficient manner, two Pennsylvania bridge replacements are highlighted below as case studies. But, first, the following six steps to help facilitate such projects are worth a review: effective scoping, continuous coordination, design flexibility, accurate impact assessment, negotiated mitigation, and proper documentation.

Effective Scoping

Scoping is a critical first step in the process of effective project development and implementation, and leads to acknowledgement of the level of environmental impacts and need for documentation. Effective scoping includes discussing the project with the affected and interested stakeholders. Starting off on the right foot with open discussions requires a clear understanding of the project's purpose and the need.

The outcomes of effective scoping—a better understanding of community context and the extent of community interest and concerns, an engineering scope of work, and an understanding of associated environmental implications—will pay dividends as the project advances into design and eventually into construction. Effective scoping is especially important for projects with complex scopes of work or significant environmental issues, such as the replacement of a bridge listed or eligible for listing on the National Register of Historic Places. Identifying the environmental issues during the scoping process enables the project team to factor responses to them into the budget, schedule, and design—right from day one.

Effective early involvement of agencies and the public also goes a long way toward avoiding future surprises. The last thing any design engineer wants to hear is that a previously unidentified or unrecognized issue is going to require a change in the project design.

Project scoping is an appropriate time to identify and involve stakeholders and jurisdictional officials who might have an interest in the project. Identifying these groups early in the planning process enables the project team to better understand the coordination that will likely be required. By identifying these groups and individuals, experienced project managers might be able to predict certain design requirements and environmental impacts and identify likely mitigation measures that will need to be incorporated into the project, thus saving time and budget.

Key questions to ask include the following: (1) Are all the resources that are present in the project area identified? (2) Which resources should be avoided at all costs or impacts on them minimized? (3) What are the appropriate methodologies for evaluating the important resources? Sometimes, agencies and the public employ different terms for similar concepts. Designers need to be vigilant to ensure that they are communicating effectively with stakeholders and that all sides understand each other.

Continuous Coordination

During scoping, the project team should initiate coordination with the stakeholders and jurisdictional officials. The earlier in the project process the coordination begins, the sooner the project team will be made aware of the concerns and desires of the involved parties. Similar to the benefits of effective scoping, knowing the concerns and desires early in the process will pay dividends as the project advances into design and eventually into permitting and construction.

Such dividends include the likelihood of adequate time for the identified issues to be considered or addressed during the planning, preliminary engineering, and design processes. If the stakeholders' issues and concerns are addressed and resolved early, the project should move through permitting and into construction with little delay. This concept holds true for both large- and small-scale projects, but is particularly applicable to those small-scale projects that have a number of environmental issues that need to be resolved within the confines of a compressed project schedule. Large-scale projects generally are recognized as needing more time to get through the NEPA and preliminary engineering processes. With projects that are small from an engineering perspective, however, often no extra time is given to resolve potential environmental complexities.

Kevin Starner, Skelly and Loy

The coordination occurring in this meeting between representatives of PennDOT and other stakeholders took place early in a project development process.

Kevin Starner, Skelly and Loy

Staking out a limit of disturbance, as this worker is doing, is one method of assessing a project's impact. Everything inside the survey flagging on the tree and the riverbank—forestland, wetlands, and threatened or endangered species—could be impacted by a bridge replacement.

"Design engineers might not understand or appreciate the importance of early coordination, but anyone who has ever been tasked with getting stakeholder buy-in or agency concurrence as part of the environmental approval process soon learns just how important early coordination is," says Okin.

Early coordination earns trust and shows stakeholders and officials that the project team is interested in their input. Further, during the early coordination process, the team provides the stakeholders and officials with important information about the project before significant design work has been completed. This involvement affords those parties the opportunity to have their particular concerns factored into the engineering design from the beginning, avoiding potentially costly design changes later in the process.

Design Flexibility

Design flexibility is important when a project is faced with environmental challenges. Maintaining the ability and willingness to make modifications and adjustments to the design in order to avoid or minimize certain environmental impacts can make the difference between successful project delivery, no project delivery, and unnecessary delay. In certain cases, relatively minor changes at the request of the stakeholders or officials can result in achieving the changes needed to move forward.

Design flexibility for small-scale reconstruction projects might involve shifting a proposed widening from one side of the road to the other, choosing an alternate bridge type, or using reduced design criteria, such as 3R (resurfacing, restoration, and rehabilitation) standards for decreased shoulder and lane widths. Now, with Pennsylvania's current Smart Transportation Initiative, it is markedly easier for design engineers to be flexible with their project designs when needed. Smart Transportation principles afford greater flexibility in an effort to better meet local needs and accommodate environmental resources.

If design flexibility can assist project delivery, then rigidity of design can, in certain instances, be counterproductive. Design engineers who remain unnecessarily committed to design criteria not related to safety could face an uphill battle winning over stakeholders and officials. A cooperative process of identifying concerns and working to resolve them in a mutually acceptable fashion might very well involve some modifications to the project design. A design should never be modified, however, to the point of compromising public safety.

Accurate Impact Assessment

Most transportation projects for infrastructure improvement require some level of assessment of environmental impacts. Assessing impacts accurately is key to moving a project forward in a timely and effective manner. Mistakes or oversights in this process, such as inadvertently missing a resource or not accurately quantifying an impact, can result in significant delays in approval and permitting for the project.

Accurate impact assessment ensures that each and every environmental resource and the project's effect on those resources have been identified and accounted for as part of the project's NEPA review process or permit application. Impacts can be reported to stakeholders and officials with the intent of negotiating a mutually acceptable mitigation package (more on that later). In some cases, it might be necessary to acquire written concurrence from them with respect to certain project impacts, such as a minor impact to a publicly owned park, recreation area, wildlife refuge, or historic site of national, State, or local significance. In these cases, accurate impact assessment is key to avoiding unnecessary delays in the schedule brought about by the need to recoordinate changes in the project impacts with the appropriate officials or stakeholders. Unfortunately, this is sometimes unavoidable with design-level changes that occur between preliminary engineering and final design. When this happens, environmental impacts should be reevaluated, and the new changes should be recoordinated with the stakeholders and officials.

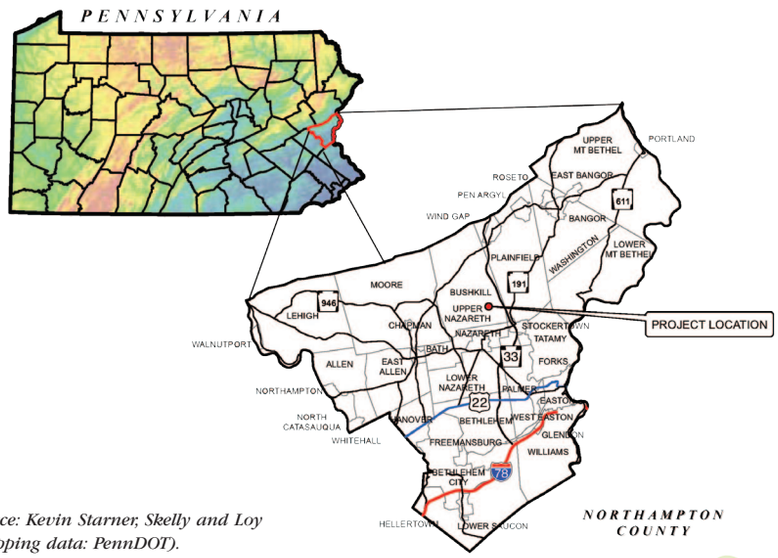
Negotiated Mitigation

Mitigation is a means that a project team can use to avoid, minimize, rectify, or compensate for the impacts of a project on a particular resource. From a project team's perspective, mitigation is the list of agreed-upon items that need to be included or incorporated into a project's plans or contract to ensure that the items are implemented, as a condition of satisfying NEPA. From a stakeholder's or official's perspective, mitigation is the commitment for avoidance, minimization, and compensation that needs to be included in order to resolve impacts on the environment. Regardless of perspective, project teams that work with stakeholders and officials to identify mutually acceptable

mitigation measures will get the job done for both sides of the table.

"Anyone who has been involved in an environmentally challenging project requiring concurrence from the stakeholders or officials understands the importance of negotiated mitigation," says Okin. In some cases, without negotiated mitigation, obtaining concurrence on a project from certain stakeholders or agency officials on mitigation measures for a minimal impact finding or a threatened/endangered species impact would be impossible. Uncoordinated, ineffective, or unsuccessful mitigation can cause stakeholders or officials to refrain from issuing their concurrence or permit. Therefore, identifying and developing a mutually acceptable mitigation package is a key component of the NEPA process for any project involving environmental impacts.

Henry's Woods Project Location



Source: Kevin Starner, Skelly and Loy (Mapping data: PennDOT).

Proper Documentation

Effective scoping, early coordination, design flexibility, accurate impact assessment, and negotiated mitigation can all be undone by not having the proper documentation of the project coordination process. Keeping accurate records, securing the appropriate written concurrences, and preparing the applicable documentation of NEPA decisions and commitments are central to the successful delivery of environmentally challenging small projects, or any projects. Gaps or inaccuracies in any of these documentation records can result in delays in project delivery, specifically in obtaining notices to proceed and permits.

Proper documentation could include, but is not limited to, meeting minutes, written correspondence, emails, telephone communication logs, memoranda, and notes for the project file. Maintaining an accurate project file is necessary to demonstrate that regulatory requirements have been satisfied. Use of FHWA's Planning and Environmental Linkages questionnaire is one method that can be used to document the coordination process that typically occurs during the planning phase of project development. The questionnaire and instructions for using it can be found at www.environment.fhwa.dot.gov/integ/pel_quest.asp.

Similarly, certain environmental requirements mandate specific written concurrences from the stakeholders and officials to comply with those requirements. For example, application of a Section 4(f) de minimis impact finding (a minor impact on a Section 4(f) resource such as a publicly owned park, refuge, or other site) requires written concurrence from jurisdictional officials certifying that the proposed project will not adversely affect the activities, features, or attributes that qualify a particular resource for Section 4(f) protection. Section 4(f) compliance is one environmental process that requires a specific written concurrence from the appropriate jurisdictional officials.

Case Studies

Two bridge replacement projects in Pennsylvania demonstrate the importance of these six steps. Both projects involved relatively straightforward engineering scopes of work for bridge replacements. However, due to the locations of the projects and the surrounding environmental resources, they were each accompanied by a number of environmental complexities that presented challenges.

Henry's Woods Bridge Replacement

The Henry's Woods Bridge Replacement Project involved the replacement of the S.R. 1008 bridge carrying Henry Road over Bushkill Creek. The bridge is located in Bushkill Township, Northampton County, in eastern Pennsylvania.

In September 2004, flooding caused by Hurricane Ivan had

Kristina Thompson, PennDOT Engineering District 5-0

The project team used the staining seen here and concrete form liners on the outer surfaces of the Henry's Woods Bridge so that it would resemble nearby historic stone buildings.

severely damaged the existing truss bridge. The Pennsylvania Department of Transportation (PennDOT) had to remove the structure and close the road to traffic until a new bridge could be constructed. PennDOT initiated a preliminary engineering contract to move forward with replacing the bridge and reopening Henry Road to the traveling public.

From the initial scoping, the project team recognized that the replacement would be accompanied by a number of environmental impacts due to its location adjacent to the Jacobsburg State Park and Environmental Education Center and within the Jacobsburg National Historic District, which is listed on the National Register of Historic Places. Following the scoping field view, the project team conducted detailed investigations to determine the exact locations, boundaries, and physical characteristics of these resources. The team initiated coordination with the appropriate jurisdictional officials—the Pennsylvania Department of Conservation and Natural Resources (DCNR) and the Pennsylvania Historical and Museum Commission (PHMC)—to introduce the proposed project in its most general form and to solicit any preliminary questions or concerns. In Pennsylvania, the PHMC functions as the State Historic Preservation Officer, a key official in the Section 106 process of the National Historic Preservation Act.

As the project advanced into the design process, coordination with these two jurisdictional officials occurred on a routine basis. The project team held a special agency coordination meeting with local and State representatives of the DCNR to discuss the design of the proposed replacement bridge, assess the impact on the park, and identify mutually acceptable mitigation measures.

Further, the team coordinated with the PHMC regarding impacts on the Jacobsburg Historic District, via submission of a Section 106 (of the National Historic Preservation Act) determination of effect report. Because the boundaries of the State park and the historic district overlap, the PHMC accepted the mitigation measures identified by the project team in consultation with the DCNR. These mitigation measures included the use of minimum design criteria to reduce the total width of the proposed replacement bridge by 4 feet (1.2 meters), formalization of a formerly unofficial PennDOT winter maintenance program to assist the DCNR with snow removal at select park locations, and application of context sensitive design via the use of concrete form liners and staining on the outer surfaces of the proposed replacement bridge to resemble historic stone buildings within the general project area.

As a result of this design flexibility and negotiated mitigation, the project team was successful in receiving concurrence on a "no adverse effect" finding under Section 106 of the National Historic Preservation Act and from both the DCNR and PHMC. These findings enabled the project's Section 4(f) uses to be documented as a de minimis finding of minimal impact. The project's NEPA requirement was subsequently processed by way of the preparation of a Pennsylvania Categorical Exclusion evaluation allowing the project to advance into final design and construction in a timely and efficient manner.

"This was an early example of PennDOT District 5 using the design flexibility concepts to balance the needs of the traveling public with the important cultural and natural resources surrounding the project," says Gerald Fry, P.E., who was head of the PennDOT District 5-0 Design Services Division at the time.

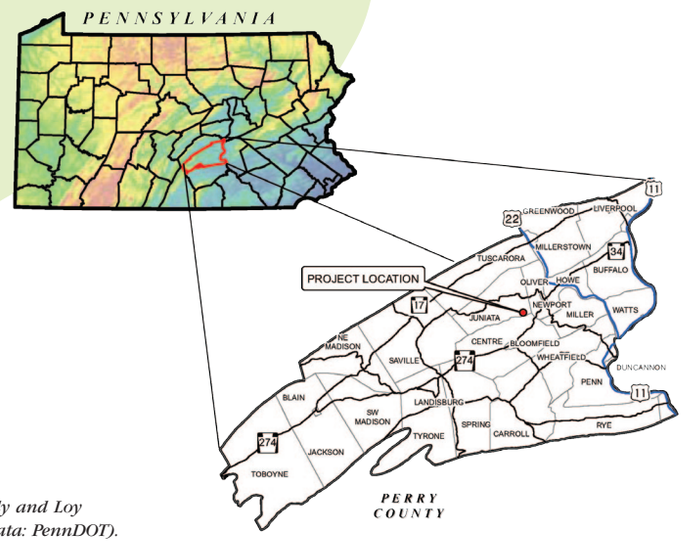
Little Buffalo Bridge Replacement

PennDOT's Little Buffalo Bridge Replacement Project involved the replacement of the S.R. 1011 bridge carrying State Park Road over Little Buffalo Creek. The bridge, located in Centre and Juniata townships, Perry County, in south-central Pennsylvania, was considered to be structurally deficient and functionally obsolete. To improve motorist safety and ensure continued public access, PennDOT programmed the bridge for replacement.

As with the Henry's Woods Bridge, the project team recognized from the initial scoping that the Little Buffalo Bridge project was accompanied by a number of environmental impacts. In this case, the issues were due to the bridge's location within Little Buffalo State Park and the Little Buffalo Historic District, which is listed in the National Register of Historic Places. Further, the project team found that the Pennsylvania Fish and Boat Commission (PFBC) stocked this stretch of Little Buffalo Creek with trout. The project would therefore be subject to timing restrictions (March 1–June 15) on instream construction to avoid conflicts with the spring season for trout fishing.

Working under contract to PennDOT's Engineering District 8-0,

Little Buffalo Project Location



Source: Skelly and Loy (Mapping data: PennDOT).

Doug Dinsmore, Skelly and Loy

Located entirely within a State park, the Little Buffalo Bridge project involved the replacement of the existing S.R. 1011 bridge carrying State Park Road over Little Buffalo Creek. The historic tavern is visible in the background.

the project team moved forward into preliminary engineering. Almost immediately, PennDOT contacted the local DCNR park manager to inform him of the proposed bridge replacement and to solicit any initial questions or concerns.

Once the project team had established a preliminary bridge design, the team held a special meeting to coordinate with local and State representatives of the DCNR to discuss the proposed design, assess impacts on the park, and identify mutually acceptable measures to minimize and mitigate those effects.

As a result of this meeting, the team incorporated several parkland improvement activities, such as parking upgrades, trail adjustments, and signage enhancements, in the area of the proposed replacement. The team also agreed to a context sensitive design incorporating the use of concrete form liners and staining on the outer surfaces of the proposed replacement bridge to resemble the stone foundation of an adjacent historic tavern.

In addition, DCNR officials indicated that they were concerned about the project schedule in that they wanted the road to be open during the park's peak use period from Memorial Day to Labor Day. PennDOT representatives acknowledged the burden that would be placed on the park by a road closure during peak use. They agreed to implement the construction phase as early as possible so that the road would open by Memorial Day.

However, the early opening would be possible only if the project could be exempted from the PFBC's timing restriction of March 1–June 15 on instream construction. The project team and DCNR park manager held a joint meeting with local and State representatives of the PFBC to discuss the possibility of a waiver on the timing restriction. PFBC officials also recognized the burden that a summer road closure would place on the park and agreed to the waiver, contingent upon the inclusion of some stream enhancement work as part of the proposed replacement project.

Finally, the project team met with the local historical society and prepared a Section 106 determination of effect report to document the project's effect on the Little Buffalo Historic District. For this project, the local historical society had no concerns and indicated that they would defer to the judgment of the DCNR in regard to concurrence. The project team submitted the determination of effect report to the State's Historic Preservation Office and was successful in achieving concurrence on a Section 106 "no adverse effect" finding for the project.

As with the Henry's Woods Bridge Replacement Project, the Little Buffalo project team was able to document the proposed project's Section 4(f) uses by way of a de minimis use finding. The project's NEPA requirement was processed by way of the preparation of a documented Categorical Exclusion evaluation. Completion of this environmental documentation enabled the project to advance without delay into final design and construction more quickly.

Final Thoughts

These two case studies illustrate the successful application of the six steps to achieve construction in a timely and efficient manner. As demonstrated by these examples, even relatively minor projects from an engineering perspective can be burdened by significant environmental challenges. In some instances, when not considered early, these challenges can result in delays in the NEPA review process and in delivering the project to the traveling public.

Environmental challenges are one of many things that may have the potential to increase the overall cost of projects by requiring special design considerations or mitigation measures. However, these challenges are also ones that can be reduced through implementing the project delivery concepts outlined above. Environmental challenges that are identified at the outset and effectively factored into all aspects of the process, including the overall schedule and budget, then are much less likely to cause project delays. Consequently, these steps can have an impact on advancing the project through the NEPA process in a timely and efficient manner, while simultaneously resulting in a better project.

Kevin J. Starner, CEP, is a senior project manager and environmental specialist at Skelly and Loy, Inc. – Engineering and Environmental Consultants in Harrisburg, PA. He has been with the firm for 14 years and specializes in the preparation of NEPA and Section 4(f) documents for transportation projects. He holds a bachelor's degree in geoenvironmental studies from Shippensburg University and is a certified environmental professional with the Academy of Board Certified Environmental Professionals.

For more information, contact Kevin J. Starner at 717-232-0593 or kstarner@skellyloy.com.

Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Management and Administration

FHWA Officials Join DC Mayor to Open Trail Bridge

Deputy Federal Highway Administrator Greg Nadeau and the Federal Highway Administration's (FHWA) District of Columbia Division Administrator Christopher Lawson recently joined Washington, DC, Mayor Vincent Gray for a ribbon-cutting ceremony to open the Anacostia Riverwalk Trail bridge over the railroad tracks on the west side of the Anacostia River, in the southeastern section of the District of Columbia. The ribbon-cutting is the latest milestone for a $50 million network of trails in the District, which received $33 million in Federal funding.

Deputy Federal Highway Administrator Greg Nadeau, center left, and FHWA DC Division Administrator Christopher Lawson, center right, cross the recently opened Anacostia Riverwalk Trail bridge.

When completed, the 20-mile (32-kilometer) Riverwalk Trail will connect pedestrians and bicyclists to a network of offstreet routes running through 16 waterfront neighborhoods and will provide benches, bike racks, and interactive maps. The project will augment local parklands by providing improved access to waterfront destinations. It also will improve water quality by controlling erosion from wetlands adjacent to the Anacostia River and preventing sediment from entering the river. Nationally, the Riverwalk Trail will provide access to the East Coast Greenway, a network of bicycle trails linking Maine to Florida.

The new bridge completes the Riverwalk Trail connections west of the Anacostia River. Another bridge opened this summer crosses the railroad tracks and completes connecting trails running along the east side of the river.

USDOT-Commerce Partnership Promotes U.S. Manufacturing

USDOT is teaming with the U.S. Department of Commerce (Commerce) to encourage the creation of jobs in domestic manufacturing and opportunities for U.S. suppliers through transportation investments. Through the Hollings Manufacturing Extension Partnership (MEP), part of Commerce's National Institute of Standards and Technology, USDOT will use U.S. manufacturers and suppliers for work on highways, railways, and transit projects. The arrangement will help ensure that manufacturers meet USDOT's strict "Buy America" standard while creating jobs.

As part of this agreement, FHWA will partner with MEP to help identify U.S. manufacturing capabilities for producing new technologies and emerging products for the Nation's highways. For example, FHWA tasked MEP with identifying manufacturers with production facilities suitable for fabricating the specialized steel fibers used in ultra-high performance concrete. Currently, the steel fibers are made only overseas.

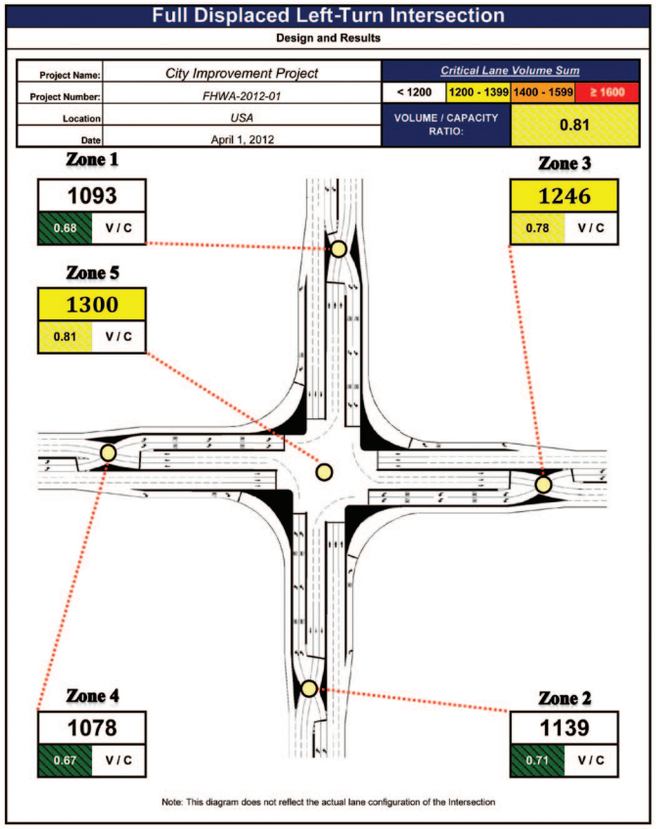
MEP serves more than 34,000 suppliers nationwide and helps them retool their manufacturing capabilities to meet demand, compete in the global marketplace, and sell U.S.-made goods overseas. Leveraging the assistance of more than 1,300 manufacturing experts in more than 350 locations, MEP will assess suppliers' production and technical capabilities to match them with viable business opportunities that otherwise might have gone to foreign suppliers. This effort will help ensure maximum economic benefit for taxpayer-funded transportation investments across all modes.

Technical News

Sketch Tool Enhances Capacity Analysis of Junction Designs

FHWA's Office of Operations Research and Development (R&D) recently developed a spreadsheet-based sketch planning tool to analyze select types of innovative or alternative junction designs using directional traffic volumes. The junction designs include at-grade intersections, interchanges, mini-roundabouts, and full-size roundabouts with one, two, and three lanes. Researchers can evaluate the performance of these designs using a volume-to-capacity ratio to provide a planning capacity assessment at each crossing. Known as Capacity Analysis for Planning of Junctions (CAP-X), the tool expands on FHWA's 2009 release of the Alternative Intersection Selection tool.

FHWA developed the CAP-X tool as a workbook in Microsoft® Excel®. The only data that need to be input are volume counts and number of lanes. The workbook



The Capacity Analysis for Planning of Junctions sketch tool helps planners analyze junction designs, such as the full displaced left-turn intersection shown in this screen capture. *Source: FHWA, Capacity Analysis for Planning of Junctions.*

has 32 spreadsheets that analyze 18 different types of innovative junctions. Some of the key junctions are displaced left turns, mini-roundabouts and multilane roundabouts, double crossover diamonds, and single-point interchanges.

According to FHWA officials, CAP-X is a simple and cost-effective planning tool that will help users focus on developing effective intersection and interchange designs prior to conducting more complex and demanding traffic simulations.

For more information, visit http://tsi.cecs.ucf.edu /index.php/cap-x.

Online ASR Reference Center Updated

FHWA's online ASR Reference Center includes the most current information on alkali-silica reactivity (ASR). Launched under FHWA's ASR Development and Deployment Program in 2009, the center now contains more than 300 specifications, guidance documents, test methods, and other references.

A reaction occurs when silica in some aggregates and alkalis in concrete combine with water to form a gel-like substance known as ASR. As the gel absorbs water and expands, it can cause the concrete to crack, leading to premature deterioration and loss of service life for concrete pavements and structures. FHWA's ASR Development and Deployment Program focuses on providing information and technologies that can help prevent and mitigate the problem.

Dr. Benoit Fournier, an associate professor of geology at Laval University in Quebec, Canada, draws a grid on a concrete barrier to measure crack widths and determine the cracking index, which is used to estimate expansion and evaluate ASR damage.

Designed for quick and easy access, the reference center features an overview of ASR, as well as research reports and State specifications. Also featured are case studies from around the world, including summaries of field trials that document treatment methods and test results. Site visitors also will find specifications and guidance from international organizations, such as the Canadian Standards Association and the International Union of Laboratories and Experts in Construction Materials, Systems, and Structures.

For more information, visit www.fhwa.dot.gov /pavement/concrete/asr.cfm.

Public Information and Information Exchange

National Survey Reveals Attitudes On Distracted Driving

The National Highway Traffic Safety Administration (NHTSA) recently conducted the first of several planned national surveys on distracted driving. The surveys aim to monitor the public's attitudes, knowledge, and self-reported behavior related to cell phones, texting, and driver choices. About three-quarters of survey respondents (80 percent of men; 73 percent of women) indicated that they answer calls on trips, and the majority of these respondents (66 percent) answer and continue driving. Close to half of these (45 percent) keep the phone in their hands while driving.

Five percent of survey respondents reported being willing to place calls on all driving trips; 10 percent on most driving trips; and 26 percent on some driving

trips. About one-third of respondents (32 percent of men; 37 percent of women) considered a driver who was talking on a cell phone and holding the phone as "very unsafe."

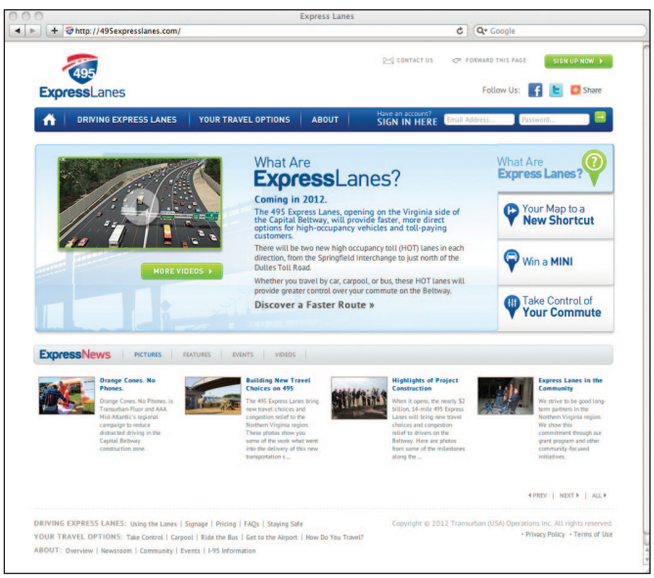
When asked how they thought their own driving changed when they were sending text messages or emails, 25 percent responded that "it makes no difference." Thirty-one percent of respondents said they "drive slower" when texting or emailing, and 8 percent of men and 6 percent of women said they "drift out of their lane." However, as passengers, almost all respondents considered a driver who was sending a text message or email (86 percent of men; 90 percent of women) and reading emails or text messages (84 percent of men; 88 percent of women) "very unsafe." Nine of 10 respondents support laws that ban texting, and 6 of 10 support laws that ban all phone use while driving.

Findings from the survey provide further evidence that distracted driving is a complex problem that is both hard to measure and difficult to address, given conflicting public attitudes and behaviors. The results also point to the need to continue focusing on education, laws, enforcement, and vehicle design to help keep drivers' attention on the road.

For more information, visit www.distraction.gov/download/research-pdf/8396_DistractedDrivingSurvey-120611-v3.pdf.

Virginia Prepares Drivers for New Express Lanes

The Virginia Department of Transportation (VDOT), with partner Transurban-Fluor, recently launched an educational campaign to prepare Virginia drivers for the change coming to I–495, the Capital Beltway, in late 2012. The high occupancy toll (HOT) lanes, known as the 495 Express Lanes, will provide options for faster, more predictable trips on the Capital Beltway in Virginia. The name of the project was changed from HOT lanes to Express Lanes to help familiarize drivers with what they will see on the onroad signage.



The new "495 Express Lanes" Web site, shown in this screen capture, helps drivers understand what to expect when the lanes open in Virginia in late 2012.

The 495 Express Lanes team unveiled a new Web site, www.495ExpressLanes.com, as the first step in a year-long campaign focused on educating the community on how to take advantage of the new travel options safely once the lanes open. The site includes detailed maps outlining how each interchange will work and lane safety information. Travelers can access the site to plan routes, obtain customized directions, and sign up for email alerts.

The 14-mile (23-kilometer) express lanes will be free of charge for buses, motorcycles, emergency vehicles, and carpoolers with three or more people. Other drivers may choose to pay a toll for a faster, more predictable travel option. The first roadway of its kind in Virginia, the lanes will use dynamic pricing based on real-time conditions to keep traffic flowing. VDOT implemented the express lanes project with its private partners to provide relief from heavy congestion in the area. According to the Texas Transportation Institute's *2011 Urban Mobility Report*, the Washington, DC, area has the worst traffic congestion in the United States.

For more information, visit www.495ExpressLanes.com.
VDOT

Phase VI of Study on Low Cost Safety Improvements Underway

FHWA's Offices of Safety R&D and Infrastructure R&D recently initiated Phase VI of the Evaluation of Low Cost Safety Improvements Pooled Fund Study. Phase VI is a pioneering study of pavement improvements that have the potential to reduce the frequency and severity of run-off-the-road crashes. The study involves statistical evaluations of before-and-after crash and pavement data to determine which safety improvements are most effective. Specifically, researchers will evaluate various improvements made to flexible and rigid pavements. Expected outcomes include development of crash modification factors, economic analyses of costs and benefits, and technical recommendations.

With 29 States involved, the effort is the second largest FHWA pooled fund study, and research is expected to continue beyond 2017. The goal of the study is to develop reliable estimates of the effectiveness of the safety improvements identified in the *National Cooperative Highway Research Program Report 500* guides. To develop the estimates, FHWA is conducting scientifically rigorous before-and-after evaluations at sites in the United States where these strategies have been implemented.

For more information or to participate in this safety performance research program, contact Roya Amjadi at roya.amjadi@dot.gov or Jim Sherwood at jim.sherwood@dot.gov.

FHWA Launches Online Toolbox For Bridge Preservation

State and local departments of transportation (DOTs) face a number of challenges in preserving bridges, including an aging inventory, increases in traffic and congestion, limited funding, and rising costs for labor and materials. To help, FHWA developed a new online compendium of information and strategies related to bridge preservation. The Bridge Preservation Toolbox, available at www.fhwa.dot.gov/bridge/preservation, is structured into four main categories: legislation and policies, bridge management, preservation treatments, and research and development.

The legislation section includes the latest on Federal, State, and local laws and policies related to bridges. This section also features background information on terminology and links to Federal and State resources, including FHWA's *Bridge Preservation Guide* (FHWA-HIF-11-042). Under the bridge management section, resources include guidance from FHWA and States on topics such as condition assessments, performance measures, strategies, cost data, deterioration trends, and life-cycle cost analyses. The section on treatments features information on methods and procedures for preservation and maintenance, including repairs and protective systems. In the section on research and development, users can find technical presentations, details on standards and specifications, reports from the National Cooperative Highway Research Program, and information on training opportunities.

For more information, visit www.fhwa.dot.gov/bridge/preservation.

USDOT Offers Free Online ITS Training

The Intelligent Transportation Systems (ITS) Professional Capacity Building Program is offering free online training on ITS standards. The 18-module series is aimed at practitioners in State and local highway agencies and transit agencies who seek the skills needed to procure, implement, and operate standards-based devices and equipment. The training also is applicable for consultants, system designers and integrators, and system testers.

The nonproprietary communications interface standards define how devices interconnect and exchange data to support the delivery of ITS services across a multimodal transportation network. The USDOT program has teamed with public highway and transit agencies and with standards development organizations to develop nearly 100 standards for use in ITS implementations.

USDOT encourages agencies to incorporate ITS standards into new systems, as well as in upgrades and enhancements to existing systems. Among other benefits, the use of adopted standards has the potential for reducing life-cycle costs. In addition, consistent and widespread use of standards will enable public agencies and private organizations to share information across disparate networks. This sharing of information will result in improved coordination and delivery of transportation services on a regional basis and, collectively, to a safer and more efficient national transportation network.

For more information or to access the free training modules, visit www.pcb.its.dot.gov/standardstraining.

Internet Watch

by Kate Sullivan

Web Site Guides Roadside Revegetation

Road construction can drastically disturb the environment, stripping vegetation, severely compacting the soil, and leaving slopes vulnerable to erosion. Traditional efforts to revegetate roadsides after construction can result in slope failures, water contamination, weed infestation, or decreased landscape aesthetics.

In recent years, however, the Federal Highway Administration (FHWA) has assumed a leadership role in proactive environmental stewardship, establishing sustainable roadside vegetation as an essential and cost-effective practice for improving the safety of roads and associated environments.

In 2003, the Coordinated Technology Implementation Program (CTIP), a cooperative technology deployment and sharing program between the FHWA Office of Federal Lands Highway and Federal land management agencies, launched an effort to develop a comprehensive manual on best practices for using native plants to revegetate roadsides after construction. The result was the 2007 publication of *A Manager's Guide to Roadside Revegetation Using Native Plants* (FHWA-WFL/TD-07-006) and the manual *Roadside Revegetation: An Integrated Approach to Establishing Native Plants* (FHWA-WFL/TD-07-005). The manual has been distributed widely to professionals throughout the country and internationally.

Recently, FHWA expanded the reach of the publications by developing them into a Web site.

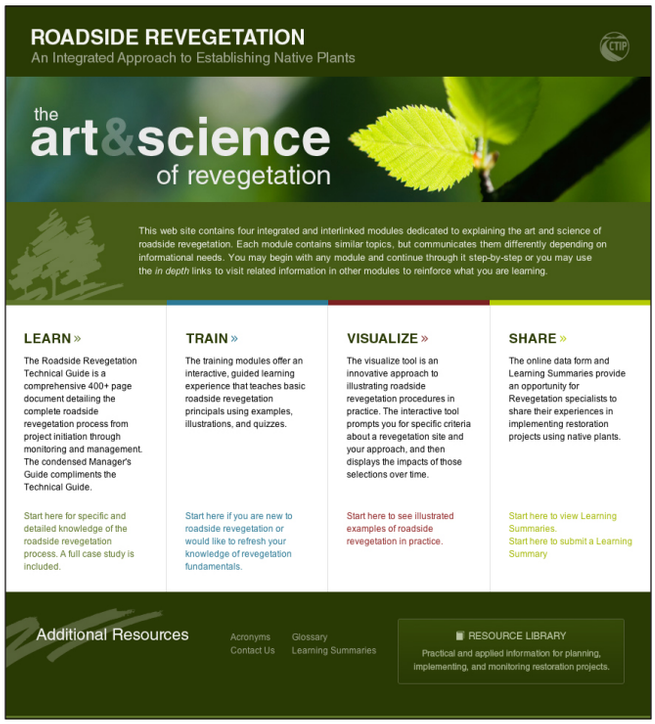
Reaching a Wider Audience

Placing the content of the publications into a Web format, in addition to reaching a wider audience, saves the considerable costs of printing and distributing the sizeable manual and facilitates future updates. Thus, CTIP launched in 2009 the Web site "Roadside Revegetation: An Integrated Approach to Establishing Native Plants," accessible at www.nativerevegetation.org.

As originally designed and launched, the site had three major modules: learn, train, and visualize. The first section contains all of the information from the *Roadside Revegetation* manual and is presented in an easy-to-navigate, chapter-by-chapter manner. The manual and the *Manager's Guide* are both available for download in this module. The next section—train—encompasses six online training modules that highlight the major steps in the revegetation process, with relevant links to additional information.

The third section of the site—visualize—uses interactive features to show how variables can influence the effectiveness of site revegetation. The user can select what to plant, and the Web site will provide a conceptual drawing of how the area will look in 1, 5, or 20 years.

In 2011, FHWA supplemented the original site with a fourth module, share. This section enables users to submit summaries of their own experiences, as well as other useful information. Users complete a submission



form on the Web site, and a team of volunteers from the U.S. Forest Service, the U.S. National Park Service, and FHWA vets the entries.

Meeting a Growing Demand

About 1,000 individual users access the site every month, according to Amit Armstrong, manager of the Technology Deployment Program in FHWA's Western Federal Lands Highway Division in Vancouver, WA. "One of the site's major benefits is in meeting the huge demand for information on native revegetation," says Armstrong.

One reason for this demand is that in 2009, the American Association of State Highway and Transportation Officials' Technology Implementation Group chose native revegetation as an "Additionally Selected Technology." The award provides limited promotional assistance to promising projects not selected for implementation funding as a "Focus Technology." The publicity generated by this recognition has greatly increased interest in the project and visits to the Web site. In addition, a number of State and local departments of transportation have used the modules from the Web site for training their own employees on background and techniques for native revegetation.

"When you promote something new, you need to give people new tools," says Armstrong. "This work is very important—it affects slope stability and water quality, and it keeps invasive species out of an area. This is a very practical site with practical tools."

Kate Sullivan is a contributing editor for PUBLIC ROADS.

by Candice Jackson

Preparing Agencies for Emergency Evacuations

An evacuation of 1,000 or more people occurs somewhere in the United States every 2 or 3 weeks, according to a 2005 Nuclear Regulatory Commission report, *Identification and Analysis of Factors Affecting Emergency Evacuations*. Given this frequency, officials at the Federal Highway Administration (FHWA) developed training on the principles of evacuation to help transportation agencies plan for these unexpected events. In collaboration with the FHWA Office of Operations, the National Highway Institute (NHI) developed course 133107 Principles of Evacuation Planning Tutorial, now available online.

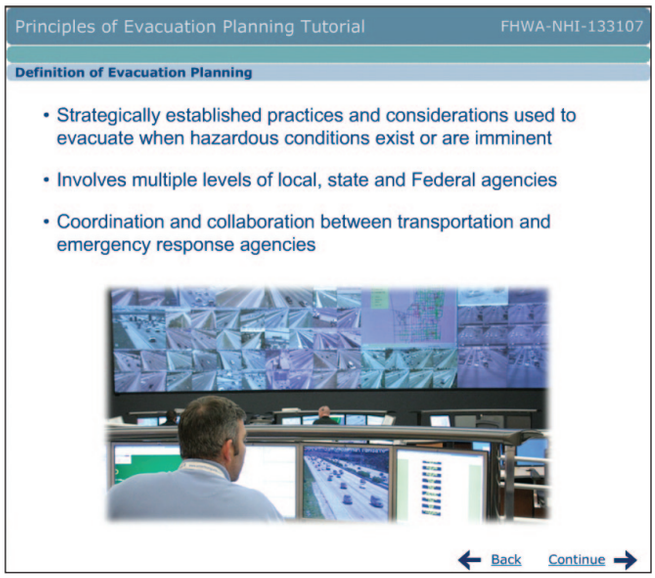
This Web-based training is free of charge and provides an overview of evacuation planning topics and key considerations. The 6-hour, self-paced course presents current and emerging evacuation planning tools, methodologies, and trends. The course also discusses the roles and responsibilities of local, regional, and State agencies involved in the evacuation process. A key component is the importance of collaboration. Multiagency and multijurisdictional planning is crucial to identifying effective practices already in use.

"The training includes a range of valuable information that can be shared between stakeholders about evacuation planning, with collaboration," says Laurel Radow, evacuations/emergencies and planned special events program manager with FHWA's Office of Operations.

Participants in the FHWA Transportation Pooled Fund Study 5(161) Security and Emergency Management Professional Capacity Building requested the training. Nine States—California, Florida, Georgia, Kansas, Mississippi, Montana, New York, Texas, and Wisconsin—contributed to the study as well as the Transportation Security Administration. The technical guidance committee for the study determined that information about evacuation planning should be distilled into a set of key elements, such as the definitions of advance-notice and no-notice evacuations and the stages of all-hazards preparedness. The elements presented in the training can be used by planners from various agencies, including highway agencies at the State, local, and tribal levels.

Real-World Applications

The course presents real-life scenarios and discusses the challenges, successes, and lessons learned from evacuation plans already in use in various States and localities. One such scenario describes the plan for evacuation traffic and route planning in the event of an incident at either of the two nuclear power plants near Minneapolis and St. Paul, MN. In this scenario, planners needed to determine how to evacuate the population within a 10-mile (16-kilometer) radius of each power plant in the most efficient and timely manner.



Shown here is a screen capture from NHI's Principles of Evacuation Planning Tutorial.

In the training, a representative of a metropolitan planning organization in the area outlines the process of creating the plan and explains the incorporation of a tool called the Capacity Constrained Route Planner. This geospatial technology assesses usable routes, their capacities, and all possible connection points from origin to the evacuation destination. Using the Capacity Constrained Route Planner, evacuation planners in the Minneapolis-St. Paul area selected shorter overall routes and expanded routes near the destination, which decreased the egress time from 268 minutes to only 162 minutes.

"Use of these technologies to model responses in advance can eliminate inefficient or ineffective incident response plans and thus significantly reduce costs," says Monique Czech, traffic management center supervisor with the Washington State Department of Transportation. "Some technologies may also have application in non-emergency situations, which could be considered an indirect cost savings."

Content With a Broad Appeal

The Principles of Evacuation Planning Tutorial is the first course on this subject NHI has developed specifically as a Web-based training. The flexibility and convenience this format provides ensures that this pertinent information is readily accessible. Although designed for transportation and emergency planning professionals, the course's content could be valuable to many groups affected by emergencies. Planners with local police, public works departments, schools, and metropolitan planning organizations also would benefit from this course.

For course details and to schedule a session, visit NHI's Web site at www.nhi.fhwa.dot.gov.

Candice Jackson is a contractor for NHI.

Communication Product Updates

Compiled by Michael Thoryn of FHWA's Office of Corporate Research, Technology, and Innovation Management

Below are brief descriptions of communications products recently developed by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. All of the reports are or will soon be available from the National Technical Information Service (NTIS). In some cases, limited copies of the communications products are available from FHWA's Research and Technology (R&T) Product Distribution Center (PDC).

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
Telephone: 703–605–6000
Toll-free number: 1–888–584–8332
Web site: www.ntis.gov
Email: customerservice@ntis.gov

Requests for items available from the R&T Product Distribution Center should be addressed to:

R&T Product Distribution Center
Szanca Solutions/FHWA PDC
13710 Dunnings Highway
Claysburg, PA 16625
Telephone: 814–239–1160
Fax: 814–239–2156
Email: report.center@dot.gov

For more information on R&T communications products available from FHWA, visit FHWA's Web site at www.fhwa.dot.gov, the FHWA Research Library at www.fhwa.dot.gov/research/library (or email fhwalibrary@dot.gov), or the National Transportation Library at ntl.bts.gov (or email library@dot.gov).

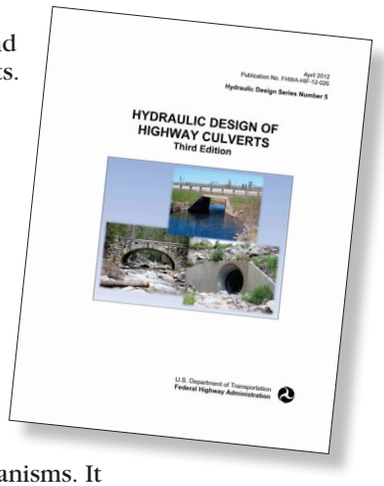
A New Path to the Future Transportation System (Fact Sheet)
Publication Number: FHWA-HRT-12-021

An FHWA project called Feasibility for a New Concept of Integrated Active Transportation Systems focuses on developing the concept of an integrated transportation system for the future. Sponsored by FHWA's Exploratory Advanced Research (EAR) Program, the project launched in 2009, and researchers at the University of California at Berkeley are conducting the study. An integrated, active transportation system would enable a seamless connection of vehicles, modes of transport, and infrastructure systems to enhance mobility, safety, and energy efficiency.

The project seeks to understand the necessary technical capabilities for such a comprehensive system and the social, political, economic, and legal factors that will govern its realization. Research is aimed at identifying technologies and developing a broad strategic framework for the evolution of a more integrated transportation system. This fact sheet discusses the research needs, goals and risks of the study, and next steps.

The document is available at www.fhwa.dot.gov/advancedresearch/pubs/12021/index.cfm. Printed copies are available from the PDC.

Hydraulic Design of Highway Culverts, Third Edition (Report)
Publication Number: FHWA-HIF-12-026



This report provides information on the planning and hydraulic design of culverts. It includes a summary of design considerations, including hydrology, site data, and site assessments. The report offers information about the hydraulic design of the barrel (size, shape, and material), the inlet configuration (pipe end section, headwalls, wingwalls, bevels, and tapers), and an overview of design concepts for the passage of aquatic organisms. It summarizes a wide range of design topics including bends, junctions, erosion, sedimentation, site modifications, structural considerations, broken-back culverts, storage routing, and failure modes. The report also covers culvert repair and rehabilitation.

The design methodology in this publication offers a simple, consistent approach to culvert design. The report is intended for experienced designers. For those unfamiliar with the variety of flow conditions possible in hydraulic structures, Design Guideline 1 in the appendix provides a step-by-step procedure to design a culvert. Inexperienced designers are strongly encouraged to take the National Highway Institute companion course 135056 Culvert Design, which has been updated to be consistent with the third edition of this publication.

The report is available at www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=7&id=13. Printed copies are available from the PDC.

Nano Material Modeling and Simulation: Developing a New Approach to Understanding Material Behaviors by Multiple Length/Time Scale Theories (Fact Sheet)
Publication Number: FHWA-HRT-12-029

Materials, structures, and sensors are the building blocks of transportation infrastructure. With so many potential applications, a fundamental understanding of their diverse physical properties is essential for effective, ongoing monitoring and maintenance. A multiyear EAR Program study, Nano Material and Simulation by New Multiple Length/Time Scale Theories and Algorithms, conducted in partnership with The George Washington University, aims to develop a new approach to understanding the physical behavior of materials covering multiple length and time scales.

Building on existing advances in multiscale modeling theories, the research focuses on delivering new theories and computational codes to simulate material responses. Researchers anticipate FHWA using new techniques and tools from this project to investigate material failures in roadside safety equipment and critical structural elements. Helping transportation engineers and managers better understand material behavior is likely to enable improved design and a more efficient, cost-effective, and sustainable transportation infrastructure. This fact sheet includes information about delivering infrastructure solutions and improved analysis tools, while highlighting challenges, potential research risks and benefits, and plans for the research.

The document is available at www.fhwa.dot.gov/advancedresearch/pubs/12029. Printed copies are available from the PDC.

Construction of Field-Cast Ultra-High Performance Concrete Connections (TechNote)
Publication Number: FHWA-HRT-12-038

Ultra-high performance concrete enables simplification of the design of component connections while enhancing durability and streamlining construction practices. This TechNote includes information about design, prefabricated component preparation, form work, mixing and placing, initial and final curing, surface profiling, and material testing. It is intended to provide insight into the use of field-cast ultra-high performance concrete for connections between prefabricated bridge elements.

Ultra-high performance concrete is composed of an optimized gradation of granular constituents, a water-to-cementitious materials ratio less than 0.25, and a high percentage of discontinuous internal fiber reinforcement. This concrete can facilitate rapid and robust construction. As with any new technology, the first round of implementation requires extra oversight, as frontline workers adjust common practices to align with new requirements.

The document is available at www.fhwa.dot.gov/publications/research/infrastructure/structures/bridge/12038/index.cfm. Printed copies are available from the PDC.

Construction Quality Assurance for Design-Build Highway Projects (TechBrief)
Publication Number: FHWA-HRT-12-039

This TechBrief helps to clarify the roles, responsibilities, and activities related to construction quality assurance on design-build projects. On certain projects, the design-build delivery system offers several documented benefits over the traditional design-bid-build method. Although design-build offers the designer-builder more control over design, materials, and construction methods than design-bid-build, the highway agency still has an important role in assuring quality.

As agencies develop design-build procurement documents, it is important to define roles and responsibilities for designer-builder quality control and agency acceptance. Planners of large, fast-paced projects often use the design-build method, which can create challenges for conducting quality assurance activities. Coordination and communication between the designer-builder and the agency is essential for effective quality management. This TechBrief discusses quality control, quality assurance, acceptance, independent assurance, dispute resolution, personnel and laboratory qualification, nonconforming materials and workmanship, and warranties.

The document is available at www.fhwa.dot.gov/publications/research/infrastructure/12039/index.cfm. Printed copies are available from the PDC.

Conferences/Special Events Calendar

Date	Conference	Sponsors	Location	Contact
November 7–9, 2012	ICRI Fall Convention: Life Cycle Repair—Sustainability	International Concrete Repair Institute (ICRI)	Rancho Mirage, CA	Naomi White 248-848-3809 naomi.white@icri.org www.icri.org/Events/upcomingevents.asp
November 11–14, 2012	3rd International Conference on Urban Transportation Systems	American Society of Civil Engineers—Transportation & Development Institute	Paris, France	Lucy King 1-800-548-2723 lking@asce.org www.asce.org/utsconference
November 15–19, 2012	2012 AASHTO Annual Meeting	American Association of State Highway and Transportation Officials (AASHTO)	Pittsburgh, PA	Monica Russell 202-624-3696 mrussell@aashto.org www.cvent.com/d/tcq065
November 26–30, 2012	ACPA's 49th Annual Meeting	American Concrete Pavement Association (ACPA)	Marco Island, FL	ACPA 847-966-2272 acpa@acpa.org www.pavement.com/Events_and_Programs/Events/index.asp
November 28–December 1, 2012	Congress of Cities & Exposition	National League of Cities	Boston, MA	Michelle Lynch 202-626-3105 lynch@nlc.org www.nlc.org/events/coc
December 3–7, 2012	Ecobuild® America 2012 Conference and Exhibition	AEC Science & Technology, LLC	Washington, DC	Kim Enriquez 800-996-3863 kim.enriquez@aecst.com http://aececobuild.com
January 13–17, 2013	TRB 92nd Annual Meeting	Transportation Research Board (TRB)	Washington, DC	TRB Meetings 202-334-2934 mburns@nas.edu www.trb.org/AnnualMeeting2013/AnnualMeeting2013.aspx
February 5–8, 2013	World of Concrete	See conference Web site for a list of cosponsoring organizations.	Las Vegas, NV	Jackie James 972-536-6379 jjames@hanleywood.com www.worldofconcrete.com
February 9–13, 2013	NAPA Annual Meeting	National Asphalt Pavement Association (NAPA)	Scottsdale, AZ	Sandy Lucchesi 301-731-4748 sandy@asphaltpavement.org www.asphaltpavement.org

National Center for Wood Transportation Structures

Wood is everywhere in transportation. Many of the Nation's highway and railroad bridges are wood; it is also used for noise barriers, guardrail posts, marine facilities, retaining walls, and sign supports.

The National Center for Wood Transportation Structures (NCWTS) can help agencies efficiently use this sustainable resource in durable, cost-effective ways to improve transportation infrastructure.

NATIONAL CENTER FOR WOOD TRANSPORTATION STRUCTURES
www.woodcenter.org

The NCWTS brings together academia, government, and industry to:

- Integrate university and government research programs
- Support a national demonstration and technology transfer program
- Serve as an international center of excellence with an emphasis on the improved use, durability, and performance of wood transportation structures on primary and secondary roads and in rural transportation infrastructure
- Provide readily accessible current information related to research on wood transportation structures and demonstration, including research needs, current projects, and publications

The NCWTS is housed at the Institute for Transportation at Iowa State University and is maintained in partnership with the U.S. Forest Service Forest Products Laboratory, the Federal Highway Administration, and the National Park Service.

For more information, visit www.woodcenter.org.

Iowa State University
Of Science and Technology

Forest Products Laboratory
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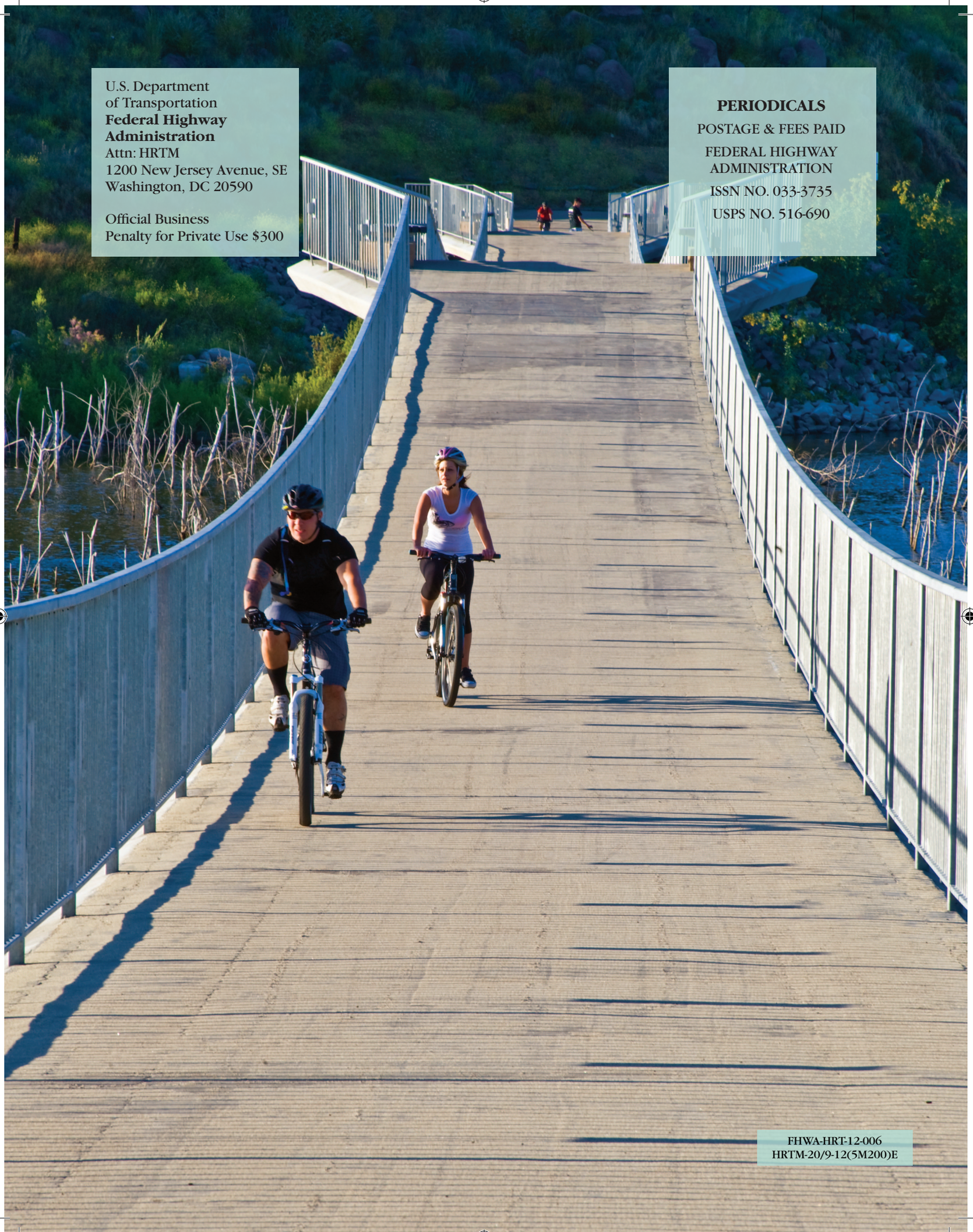
National Park Service

U.S. Department of Transportation
Federal Highway Administration



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ISSN NO. 033-3735
USPS NO. 516-690

FHWA-HRT-12-006
HRTM-20/9-12(5M200)E